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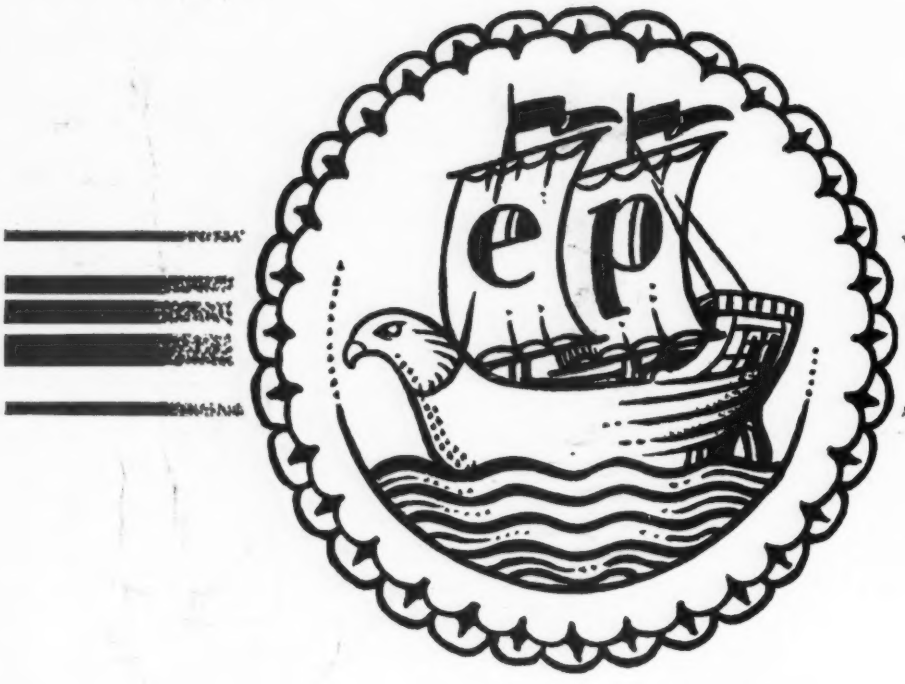
Plastics

DEALING WITH THE MANUFACTURE USES AND POTENTIALITIES OF PLASTIC MATERIALS



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Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Vol. IV JULY, 1940 No. 38

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"PLASTICS" is published in London, England, at the beginning of each month.

Head Offices: Bowling Green Lane, London, E.C.1.

Inland Telegrams: "*Pressimus, Smith, London.*"
Cables - - "*Pressimus, London.*"
Telephone - *Terminus* 3636 *(Private Exchange).*

Midland Office — 50, Hertford Street, Coventry.
Telephone—Coventry 60095 *(2 lines).*
Telegrams—"*Presswork, Coventry.*"

Northern Offices—Manchester: Deansgate House, 274, Deansgate.
Telephone—Blackfriars 5038-9.
Telegrams—"*Presswork, Manchester.*"

SUBSCRIPTION—"PLASTICS" will be mailed regularly to any address in the United Kingdom or abroad for—
Twelve issues for 15s. post free; Canada and Newfoundland 12 for 13s. 6d.; pro rata for fewer numbers.

COMMUNICATIONS—All letters regarding subscriptions, advertisements and other business matters must be addressed to The Manager, Bowling Green Lane, London, E.C.1.

TEMPLE PRESS LIMITED
Proprietors, Printers and Publishers of "The Motor," "The Light Car," "The Commercial Motor," "Motor Cycling," "Cycling," "The Motor Ship," "The Motor Boat and Yachting," "The Oil Engine," "The Aeroplane" and "Light Metals."

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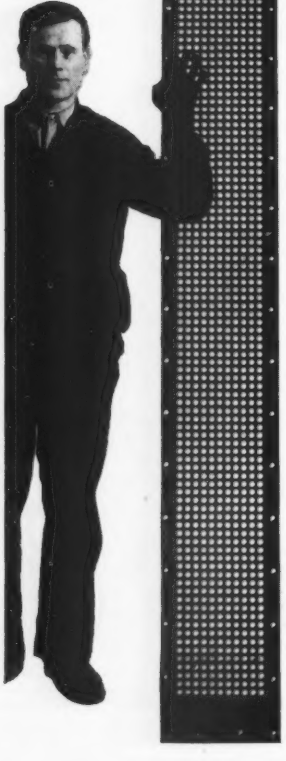

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THE MATERIAL OF INFINITE USES

Vol. IV. No. 38 JULY, 1940

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.I.C.
Offices - Bowling Green Lane, London, E.C.1

PLASTICS IN WAR TIME

ONCE again we have taken a rapid peep into the condition of the plastics industry during war time, sharing its woes and, on occasion, its joys when it is allowed to possess them. The short and very general survey we publish on another page is not fulsome in detail. But what would you? We cannot describe and certainly cannot publish, photographs which are expressly forbidden by the Censor, bless his heart! To him even a coil-former is a secret object, whose shape, and perhaps the fact that it is made by plastics, must not be divulged to the enemy.

The plastics industry has so far done well in helping the war machine. When the facts are collected after the war, and if they can be published, a heartening story will be told. We cannot divulge some of the suggestions that have been made, still less those that have succeeded in passing the requirements, but at least we can say that the Government demands are accepting plastics at a somewhat greater rate than they were at the beginning of the war. This statement, being merely relative, is not a satisfactory one, and we can say that the Government departments do not realize the full extent of the help we can give, either directly or indirectly, by replacing metals for non-war purposes.

What is wanted is a strong Committee at the Ministry of Supply, one indeed that can say to a works: "You will make this unit of plastics," and not act merely in an advisory capacity to those who approach it in order to ascertain whether an object can be made of plastics. A much wider directional force to cover all industries is required, for there would probably be sufficient metal for all those units which are best made in metal, if only plastics were used where they are best suited or where metal is not absolutely essential.

We can give one little example of no importance. But it points the way people should think in times of stress. The Germans have put on the market a moulded phenolic container for shoe polish, thus replacing a "tin" container with plastics, for, presumably, tinned plate is not abundant in that country. Here, we can assure our readers, supplies for unnecessary purposes are also not abundant, but our shoe-polish merchants are still packing their product in tins and somebody must go short.

Let us wake up our ideas and think on a broad scale.

The German shoe-polish container referred to in the above note.

Masonite Plastic Containers

ALTHOUGH the building world has now employed what is known as Masonite board for some 15 years, few details regarding the process for making the material have been divulged. One of the earliest products was an insulating board of very low specific gravity, but since those days some six different types have been introduced, each satisfying different industrial fields. The most recent Benalite is termed a lignin plastic and it appears that it is of sufficient value to make plastic containers.

Generally speaking, the Mason process consists in charging a special "gun" or autoclave with wood chips (ligno-cellulose). The "gun" is closed and saturated steam is allowed to enter until a pressure of 600 lb. per sq. in. is reached (this takes about 30 secs.). The pressure is then raised rapidly to 1,000 lb. per sq. in., held at this pressure for some seconds, and is then discharged into a cyclone separator, the chips exploding with the sudden pressure. The fibres thus formed fall into large storage tanks of water (3 parts fibre and 97 parts water) and form the stock, which then passes

to a board-forming machine similar to a Foudrinier paper machine. Blankets of the material are thus formed, from 1-2 ins. thick, and are cut off into lengths of 12 ft. These blankets are then pressed to make boards; the time of exposure to pressure within the "gun," the type of refining, the method of felting, the varying of chemicals, such as water-proofing agents, etc., and the time and pressures employed in the press give different types of boards, some of which have important structural and architectural value, termite and fungus proof properties, or are usable for flooring.

The most recent type is Benalite, in which special use is made of the plastic-forming properties of the lignin in the exploded wood. The wood, which may be soft or hard, is subjected to the same preheating treatment as described, but is held in the reacting chamber for longer periods under carefully controlled conditions of acidity. The material is then formed into sheets and these are then subjected to a pressure of 1½ tons per sq. in. at elevated temperature to secure conversion to the cured state. Benalite has a specific gravity of 1.44 and can be turned, tapped and sawn.

The physical properties of some of the Masonite products are interesting.

	Insulation Board.	De Luxe Quartrboard.	Presdwood.	Benalite.
S.G. ...	0.32	0.9	1.03	1.44
Tensile strength lb./sq. in.	194	2,200	3,200	10,000
Water absorption per cent. 24 hrs. ...	46.3	18	16	0.75
Dielectric strength ...	—	—	—	300-400 volts per mil.

The Export Group

IN our last issue we gave some details of the new Export Group for dealing with plastic goods that had been formed in May, with Mr. H. Bridge, of Thomas de la Rue and Co., Ltd., as its chairman. Since then the number of companies that have joined up in the scheme has grown to over 40. This is a very encouraging figure when one remembers that some concerns already have their own export organizations, while others are so occupied with Government work that time cannot be spent on making what are essentially peace-time goods.

The following additional concerns have now joined the Group:—

Combined Optical Industries, Ltd.
Crystalate, Ltd.
De Garrs and Allen, Ltd.
Ellison Insulations, Ltd.
Insulators, Ltd.
J. Legge and Co., Ltd.
Phœnix Telephone and Electric Works, Ltd.
Telegraph Condenser Co., Ltd.
United Ebonite and Lorival, Ltd.
Universal Plastics, Ltd.

A special selection committee set aside for inclusion in the Export Catalogue some 250 of the sample mouldings submitted by the members of the Group; and illustrations of all these moulded articles will appear in the catalogue with a brief description in English, French, Spanish and Portuguese. The catalogue is now being prepared and copies will be sent all over the world. The first step taken in this direction has already been a big one, for a little exhibition has been held in the past few weeks at the offices of the British Plastics Federation, in Pall Mall, London, of some 300 separate items. They made a brave show and we have pleasure in reproducing photographs of them on pages 158 and 159.

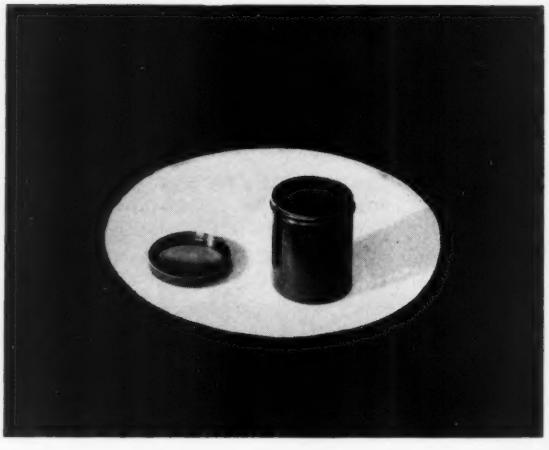
Evidence of the interest shown in the display of samples was borne out by visits from Sir Andrew Duncan, President of the Board of Trade, Sir Clive Baillieu, the Plastics Industry's executive member of the Export Council, Mr. Harcourt Johnston, Parliamentary Secretary to the Department of Overseas Trade, and Mr. D'Arcy Cooper, chairman of the Export Council Executive Committee.

The activities of the Moulding Powder Manufacturers' Group are being closely allied to those of the Moulders' Group, as indicated by the fact that the former has undertaken to subscribe half the cost of the Moulders' Export Catalogue.

Figures have been collected from both Groups showing the value of their export sales over agreed periods; and members of the Moulding Powder Manufacturers' Group have agreed upon minimum export selling prices.

New Container

We have just received from the Streetly Manufacturing Co., Ltd., their new pattern W 120 container (see photo below), recently altered so that the lid has a screw fit. It has been listed in the usual Beetle colouring at Woolworth's.



New Book Received

"A New Dictionary of Chemistry." Edited by Stephen Mial, LL.D., B.Sc. Pp. xv + 575. London: Longmans, Green and Co., 1940; 42s. The scope of this useful reference work includes brief explanations of the terms used in modern chemistry and chemical engineering, brief accounts of many chemical substances, chemical operations, drugs, vitamins, and other compounds of biological importance and brief biographical notes. We can recommend this dictionary to the chemist, technologist and student, as it contains a wealth of accurate and well-chosen information. The structural formulæ of organic compounds are very clearly printed and the printing, paper, and binding are very good.

The Moulding Industry in War Time

NINE months ago we essayed a consideration of the plastics industry insofar as it was affected by the war, ventured an analysis of the raw material situation and the part the industry was playing and hoped to play in helping on with the war effort. At that time things were in a state of flux and the situation was foggy. The condition of things even now is by no means as clear as it might be, but the march of events has taken certain fairly well-defined courses. With time, the dust of uncertain conjecture will settle down.

Raw Materials

Thermo-setting Resins. At the outset of the war we prognosticated, in contradistinction to the last war, when all coke-oven plants and synthetic plants were working full blast to produce the maximum quantities of phenol, that there would be no shortage of the commodity for the plastics industry. We based our remarks on the belief that picric acid, which is made from phenol, is no longer an important explosive. This has definitely proved to be the case, and if some small quantities are still used there appears ample available, despite increased production of plastics, dyestuffs, aspirin and the other multitude of normal uses. Similarly, there is plenty of cresylic acid for making the "phenolics" usually employed for incorporation in paints and varnishes and for special impregnation of fabrics, woods, etc. The price has naturally increased, but by no means in any untoward manner. An interesting comment on phenol and its availability may be made, by the action of one famous concern, Howards and Sons of Ilford. This company manufactures cyclohexanol and methylcyclohexanol, derived by the hydrogenation of phenol and cresylic acid. It is with considerable pleasure that we note that to date the price of these chemicals, which are used as solvents for resins and can be made into synthetic resins, has not increased since war broke out.

Urea resins are in a similar position. There is no lack of them and, indeed, we note that one of the great producers has enlarged and widened its production of urea-formaldehyde cements for use as adhesives for wood and many other materials of construction. Their value for aircraft work has thoroughly vindicated the claims of the manufacturers.

Demands for formaldehyde have, of course, been as great as the production of phenol and urea and supplies from synthetic sources, wood distillation and abroad have adequately covered requirements.

Supplies of wood flour have always been a danger point. At the outbreak of war the largest portion of our supplies were obtained from Sweden and adjacent country, but since the beginning of the year this important supply has been completely cut off. There are, however, fairly good stocks in this country, much is available in America, and there are a few but excellently equipped factories for producing it here.

Thermo-plastics. Of great importance in the war effort is the supply of cellulose acetate, hundreds of tons of which are used for aircraft units alone, and great quantities for eyeshields, spectacle frames and the hundred and one other objects of normal trade. The capitulation of France has dealt us something of a blow, since large quantities of Rhodoid, the product of Société Rhône-Poulenc, were imported. There are still considerable stocks of this here, but the main interest in the situation is the fact of the greatly increased production within recent months of raw material in this country by British Celanese, Ltd., and Lansil, Ltd., and of sheet and powder by BX Plastics, Ltd., Erinoid, Ltd., Cellomold, Ltd., and others, who can take care of the demands. Moreover, considerable quantities are coming in safely from America.

Also satisfactory is the situation regarding methyl methacrylate resin, known in this country under the name of Perspex and made by I.C.I. (Plastics), Ltd. Made from purely home-produced raw materials, it has proved invaluable for the production of transparent gun turrets and similar requirements for transparency on aircraft. Here, again, large quantities are available of both the sheet and the moulding powder variety, Diakon.

As for polystyrene resin, we can realize now how important was the fact, announced nearly two years ago, that the manufacture was being carried out in this country for the first time by the Distillers Company. More recently the working up of polystyrene has fortunately been undertaken also by BX Plastics, Ltd., Erinoid, Ltd., and F. A. Hughes and Co., Ltd. This material has become extremely important for many electrical, acid resisting and transparent jobs. Polystyrene, too, is made from raw materials found in this country in great abundance, so that there is no fear of cessation of the supply. The production, however, is not great and is, or should be, restricted to Government contract work or other work of an essential nature. Happily, large quantities are being worked up here from raw material received from America.

We have often bewailed the fact that calcium carbide and, consequently, the synthetic resins derived from them, were not produced in this country. In this group are polyvinyl chloride and acetate, both of which, and their co-polymers, have become of great use to industry in general and the cable industry in particular. Large quantities are being worked up from raw material imported from abroad, by F. A. Hughes and Co., Ltd. There are also signs that manufacture from carbide will soon begin here. Generally speaking, however, there appear to be adequate supplies to meet the demands.

The demands for casein, which has become a military purposes plastic, have increased greatly, but the situation is very satisfactory, there being several factories turning out the raw material.

The Moulding Industry

The moulding industry has indeed had a worrying time since the outbreak of war and, in some respects, it has been somewhat of a nightmare. The firms with the largest presses found that the motor business, so far as it affected plastics, had vanished overnight, and even the radio cabinet business seemed at one time doubtful and likely to follow suit. The change-over to Government work was far from being general at first, and some factories were content to do none at all, but to concentrate on normal work and such new

moulding as came from industry of the "metal-replacement" category, or the new jobs that accrued from general war conditions. There was plenty of opportunity in the latter two categories. Great numbers of inquiries came from industries that realized that metal and wood would be scarce. The large proportion of these came to nothing, since the inquirers had no knowledge of the plastics industry with regard to the quantity-price ratio, the ever-present problem of the mould cost or the time to make one under war conditions. On the other hand, some entirely new jobs of the metal-replacement type have been highly satisfactory, both to buyer and moulder.

We were told recently of one enormous order that had "gone west" owing to the short-sightedness of one industrial firm that fondly hoped at the beginning of the war that metal would be available. The supply suddenly ceased and, on frantic inquiries to plastic moulders was told that mould deliveries for the particular unessential units would be anything between two-five months. The concern has considered it so hopeless as to shut down entirely. With this type of company we can have little sympathy.

The main troubles in the moulding industry have been mould worries more than anything else. These are, of course, attributable to the toolmakers, who have had more than their share of worry—difficulty of obtaining castings, etc., for anything other than priority jobs and the loss of expert workers, often through reprehensible practice, tantamount to bribery. This, during the past few months, has, happily, diminished. The larger concerns in the moulding industry, with their own mould-making shops, were in a more fortunate situation, although the same difficulties of getting steel and of maintaining staff existed.

There was, on the whole, considerable dissatisfaction among the "not so large" moulders, who felt they were harshly treated in not receiving Government contracts. In fact, one moulder writes to us as follows, in answer to a query, "We have had no inquiries from the Air Ministry, although we have executed one small order. Actually, we have not expected direct work since my visit to the A.M. last year, when we were told that they required only firms who could cover the three supplies, moulds, mouldings and brass-insert work." While one can realize why at the beginning of the war Government Departments should give contracts to those concerns which could cover the supplies in question, surely, at this stage, the requirements and the industry should have been organized sufficiently so that those smaller concerns, and they are patriotic enough to want to help, could be roped in the whole scheme. There are far too many idle presses even to-day.

Nevertheless, on the whole the change-over to Government work grows apace and as the latest blow to the industry, the cutting-down of fancy goods, takes effect we hope that the loss will be replaced by what is now essential work, and the sooner the Government realizes the tremendous potential output the moulding industry is capable of the better. Luckily, there are great requirements also for non-combatant uses that can yet be considered essential in these days. The razor-case industry has assumed enormous dimensions, the plastic torch case and lamp are completely successful and A.R.P. lampshades are being sold by the hundred thousand. We must not forget that toothbrushes have become almost militarily important objects and, as for buttons, the industry cannot turn them out fast enough for the military tailors.

The situation here is very intriguing and for the first time for many years we are glad to say that the casein industry has come into its own. BX Plastics, Ltd., and Erinoid, Ltd., are the two largest concerns turning out rod and sheet for this purpose; both are almost frantically busy. Mr. Robert Dodd, our old friend of Erinoid, Ltd., writes as follows:—

> "In reply to the query that you raise as to the use of the khaki and Air Force blue which we are making in rods and sheet form, this is being used almost entirely for buttons, replacing the metal buttons on the battle dress, and we are simply overwhelmed with this business.
>
> "Casein is also coming into its own in replacing metal used for spacing washers and in many other ways. The demand for casein rods and tubes is rapidly increasing.
>
> "As regards the cellulose-acetate side of our business, the whole of this plant is engaged 100 per cent. on Government work. The film is being used for eye shields and the moulding powders for ships' fittings, again replacing metal parts.
>
> "As regards polystyrene, you are quite right as far as your information is concerned. We have been manufacturing a polystyrene moulding powder for some time now, and here, again, the whole of this output is engaged on Government orders, principally for lamp glasses."

During the past year or so another competitor to casein for buttons has entered the market, for British Industrial Plastics, Ltd., at the Streetly works, are moulding them, presumably from urea-resin powders. By the end of March, 1940, the output had trebled, but as the chairman of this company, Mr. Kenneth Chance, has remarked, "it is still insufficient to meet more than a fraction of the demand." Yet another side to the button problem is being solved by the injection process. During a recent visit to Fraser and Glass, Ltd., Mr. Fraser showed us some extremely beautiful transparent buttons injection-moulded from thermoplastic resin. We have seen many glass buttons, made in Czechoslovakia and other European countries, but they cannot compare in beauty, exactness of reproduction and design with these new buttons. Unfortunately, this is not war work, but we hope that there will be a place for them in the export market.

Under the category of A.R.P. plastics of fair importance may be considered the luminous plastic side. This started off with a rush during the early days of the war, but has down dwindled to a mere trickle. We hope there will be some demand for this during the winter months. No, on second thoughts, we hope, for obvious reasons, that there will be no demand at all! With reference to the injection moulding of cellulose-acetate powder mixed with luminous pigment, one snag was quickly discovered. Using the horizontal machines, it was found that the heavy pigment separated from the plastic and collected only in the bottom of the die.

Generally speaking, the moulding industry is still in a state of flux and is awaiting words of hope and guidance. Some of the big moulders are doing 100 per cent. on Government work, and, on the whole, the figure is between 50 per cent. and 85 per cent. Some of the smaller concerns, as we indicated before, are doing very little, if any, Government work. (Several interesting letters from toolmakers are being held over until next month.)

Protecting the Fighting Man

The Royal Society of Medicine raises the Problem of Armour Provision

THE current issue of *The Lancet* notes that a recent meeting of the Royal Society of Medicine passed a resolution to the effect that it is of the opinion that the physical protection of the members of the fighting forces can be improved by a closer collaboration between the medical profession and the appropriate technical services of the Admiralty, War Office and Air Ministry. The meeting also resolved to ask the Council of the Society to consider the formation of a committee to this end.

These important pronouncements followed the reading of a paper by Mr. Kenneth Walker and the resulting discussion which followed it. The following facts, which issue from the paper and the discussion, are extremely interesting, since they affect in part the plastics industry.

The protection of the civilian worker against accident and illness is of great concern to the Government; laws have long been instituted for such protection, and employers have, in the main, wholeheartedly co-operated to that end, yet it is claimed that the physical protection of the fighting personnel of our Navy, Army and Air Force has not been considered in the same light. What is meant by this claim is that, while the R.A.M.C. and the medical officers on board ship, etc., treat the wounds received with great efficiency, little has been done to prevent the reception of the wounds. In effect, the above meeting has reopened the problem of armour for the fighting man. The problem is old, but some new ideas have been put forward.

One important fact, not generally known to the non-medical public, was mentioned; it was to the effect that wounds due to shell splinters, which are always jagged and which may be almost spent, are probably responsible for more deaths than by bullets. The latter, at full velocity, unless they strike vital parts, do not cause deaths as frequently as a spent splinter. It is obvious, too, that the splinter, which always has a much slower velocity than a bullet, can much more readily be stopped than the latter.

The problem of giving the modern fighting man personal armour has been brought up time and again, but, with the exception of the steel helmet, nothing has been done. This was a great step forward and, we believe, was adopted only after strenuous representation to the authorities. The arguments against any increase in armour are powerful enough—any increase in weight put on him must restrict his activities. But the situation has in some respects altered greatly. Armies do not now move by long marches, but are conveyed in lorries, while there are vast numbers of men, technical and otherwise, immediately behind the lines who do not march at all, but are exposed to shellfire, bombs, etc., and could support some extra weight. Mr. Kenneth Walker suggested the use of a steel jerkin, weighing no more than 14 lb., which would adequately protect the wearer against flying steel splinters. But he made another valuable suggestion by urging the examination of "compressed canvas or bakelite material" for similar purposes, and, we understand, made the claim that this material an inch thick would stop a bullet. We do not know if this statement was based on tests, nor what is really meant by the now almost generic term "bakelite," but it is interesting that plastics have been considered of potential value for the purpose.

From our point of view, the whole problem brought up by the paper is most encouraging in attempting to bring about a collaboration between the medical profession and technical departments.

The main point we should like to stress is that the fighting man should be given more protection. He cannot be given perfect protection, but some attempt should be made with that ideal in view. If 14 lb. is considered too heavy an armament, then research should be carried out on materials which, although light and not so protective, will yet give a better protection than nothing at all.

We have all been intrigued by stories of lives being saved by cigarette cases or Bibles carried in pockets. On the Gaumont News last week we encountered a real instance. During the Queen's visit to a hospital recently she was shown a cigarette case by a soldier which had received the impact of a bullet or splinter and so saved his life. The cigarette case was obviously very thin metal and although the missile may have struck at an angle, yet it did save his life or, at least, it did save him from great injury. Therefore, we say if the steel jerkin of 14 lb. weight be too heavy, would it not be feasible to make it of much thinner steel and back it with a tough sheet of plastic material? We can well imagine a jerkin made of 1/32-in. or 1/64-in. sheet steel backed with an $\frac{1}{8}$-in. sheet of plastic being fairly protective and yet weighing less than 7 lb. It might be worth while investigating the possibility of alternate thin layers of steel-plastic adhered or moulded together into a simple shape. Alternatively, a suggestion has been made to insert a square sheet of resin-impregnated fabric into the back of the gas-mask container, which is normally carried in front of the body. This or the above-mentioned steel-plastic sheet should give some protection and would weigh only about $\frac{3}{4}$ lb. to $1\frac{1}{2}$ lb., according to which was used.

Perhaps the greatest drawback to the whole problem is not one of weight, but of irksomeness to the wearer. Both steel and plastics are rigid and we cannot pretend that the best designs will give comfort. This and other disadvantages will become apparent if research is made. But the main point is that no progress at all will be made until such research is carried out.

Apart from the soldier in the field, there is the sailor and the fighters in the air. Here the weight of armour would appear to be less important, paradoxically in the case of the airman, where weight is so important. In the latter instance the problem is not one of armouring the aeroplane, but the man, and if a jerkin will not protect him against bullets, it will probably help against anti-aircraft fire. The weight of such a jerkin would be insignificant. Alternatively, thick surrounding panels of resin-impregnated fabric should give some protection and yet be comparatively of light weight.

Plastics and the War Effort

Plastics as Alternatives for Other Materials

THE use of the word "alternatives" in the title above has been deliberate insofar as it appears to be the impression in the minds of people who are not too familiar with the plastics industry that plastic material is largely a substitute, and an inferior one at that, for older and more well-known materials, such as metal or wood. Such an impression is very far removed from the truth.

Industry in this country, taken as a whole, could not correctly be described as "plastics-minded" in the months preceding the outbreak of war, at least not to the same extent as, for instance, in Germany, where the "self-sufficiency" plan had given a tremendous stimulus to the development of synthetic products capable, wholly or in part, of replacing natural materials. As the war develops, however, it is more and more obvious to even the most conservative of minds that if this country is to pull its full weight and put itself into a position to ensure that victory for which we are all supposed to be working, available supplies of essential materials must of necessity be used only for those purposes for which no effective substitute is available and all possible means must be adopted to restrict their use in those directions where alternatives are either already available or can be adapted to serve.

There are undoubtedly a multitude of requirements directly inspired by the war which a plastic product of one kind or another can fulfil with as great, if not greater, success than materials used hitherto. There are signs in plenty that the Service Departments, who have the prime responsibility of equipping our fighting forces, are becoming more and more alive to the possibilities of plastics in conserving the use of such essential materials as metals and wood, to name only two which must now be used with the greatest possible economy. A considerable amount of research is now going on, not only at the direct instigation of Government Departments, but also by the spontaneous efforts of individual members of the plastics industry, to ascertain new directions in which plastics can be effectively used for the war effort and to evolve the best type of plastic for a given purpose.

Plastics in one form or another have, of course, been used for years past in many directions readily adaptable for armament purposes, notably the phenolic and urea materials in the form of mouldings for fitments for motor vehicles, aircraft, etc., for radio and telephone parts, instrument fittings and cases, electrical gear of all kinds and more especially in resin form for the bonding and impregnating of different materials, such as plywood, paper, fabric, etc., for the manufacture of such items as airscrews, bushings, gearwheels, insulating tubing, etc., etc. The use of the thermo-setting plastics for these and similar purposes directly concerned with war-time requirements has been stepped up very considerably, and is likely to be stepped up still further in the future. One development which the phenolic plastics should be able to achieve with a "shock-resisting" material, combined with careful design of mould, is a satisfactory production of head lamps and wing lamps for motor vehicles. This would release considerable quantities of metal for more important purposes.

Mention should be made here of two further very important plastic products, namely, methyl-methacrylate and cellulose acetate, both in sheet form, and used for aircraft fittings, such as turrets, cockpit covers, wing fairings, etc. For these purposes the thermo-plastic properties of the materials are well suited to the rapid and economic production of the many shapes and sizes of fittings required. It is an accepted fact that no material outside the plastic range can be so advantageously used or can combine in one product the strength, clarity (where this is required), exceptional resistance against shock and—not least important—the light weight of these major members of the plastics family.

In rather a different category is the use of cellulose acetate for spectacle frames. This material has long been used for civilian spectacle requirements, but for the fighting Services it has so far been considered desirable that spectacle frames should be of metal. The so-called nickel-wire frame is undoubtedly ideally suited to Service requirements, and the fact that it is essential that the spectacles worn by all members of the Forces permit a gas mask being fitted over them has been an important factor in deciding on the material to be used for the frames. This is, however, a case where possible considerable saving in the use of metal for the special type of wire employed might be effected by a judicious combination of plastic and metal.

The use of a plastic material for airmen's goggles is on rather a different plane insofar as for this purpose a completely non-inflammable material is considered essential, which rules out cellulose acetate. This latter material is also subject, within certain limits, to the effects of changing atmospheric conditions. There is little doubt that a goggle frame could be moulded from a vinyl plastic, either sheet or powder, which would not only be equally as effective as metal, but probably better insofar as it would enable special lenses to be incorporated to give the widest possible field of vision and, at the same time, properly adapted to the strength or weakness of the wearer's eyes. The great advantage of a properly selected vinyl material over cellulose acetate would be its complete non-inflammability and its resistance to deformation under changing atmospheric conditions, both of temperature and moisture. Certain experimental work now in progress may very soon turn this probability into a reality.

Another direction in which plastics already do, and undoubtedly will to a much larger extent, take the place of the natural product is the use of compounds based on poly-vinyl-chloride and also poly-iso-butylene, either alone or in admixture with other chemical products, notably the poly-iso-butylene in admixture with poly-ethylene for cable-insulation purposes, this latter more especially for high-frequency work. This is a case where the plastic materials have not only considerably greater resistance than rubber against the effects of ozone, thus giving a much longer life under marine conditions, but, what is more important, they have capacity and losses very much lower than can be obtained with rubber or gutta-percha mixes. A further point is that certain manufacturing processes necessary

when rubber is the insulating medium can be entirely eliminated, thus leading to greater speed of production. For low-frequency work, such as field telephone cable and motor-vehicle wirings, poly-vinyl-chloride has long since been proved to be much superior to the natural product, not only from the point of insulating values, but also on account of its long life, i.e., freedom from ageing, and its high resistance against a very wide range of acids and alkalis.

The electrical properties of polystyrene, which are second only to those of natural amber, are already well known, and present-day research is finding constantly increasing use for this thermo-plastic material, which can be used either by the injection- or the compression-moulding method, and can also be cast in rod and sheet form. Its extremely low specific gravity—it is one of the lightest of plastic compounds—is an added advantage, especially for aircraft requirements, in conjunction with its crystal clarity and its unlimited colour range. This material and the methyl-methacrylates can very effectively replace clear or coloured glass in a wide variety of uses and are used in large quantities for Government requirements.

The use of tubing as a fully effective alternative to glass, lead or other metal tubing, is a practical possibility with certain plastic materials, especially some of the vinyl (thermo-plastic) compounds in cases where no considerable degree of heat has to be considered. For such purposes, the acid and alkali-resisting properties of the material are important considerations, not only for the chemical industry, but also for the food industry, as these vinyl compounds can be made up in a variety of grades to meet specific requirements, and can be used in contact with any type of food product without the slightest risk. The use of all-plastic materials in the vinyl group for the holding and conveyance of cold water, as, for instance, for cisterns, flushing pipes, etc., is a fully practicable matter and will go a long way towards releasing metal and spelter for other urgent requirements. One of the chief obstacles to its immediate and wide adoption for such purposes is probably the lack of suitable types of machines for its fabrication. The advantage which the vinyl product has for these purposes is that, being thermo-plastic, it can be readily shaped to any degree required to meet problems of fitting into position, whereas the extruded tube or other section in the thermo-setting phenolic or urea compounds, which is also a fully practicable production matter, can be considered only in straight lengths or in fairly wide and fixed arcs. Nevertheless, the phenolic or urea extrusion has its own place in the present scheme of things, and is an effective substitute for metal for such purposes as insulating conduits, channels and runways of various shape and size, where no great stress has to be met with. It is also a splendid alternative both to metal and to wood as a non-electrical and non-heat-conducting material for instrument handles of various kinds, as pendants and standards for electric light fittings, and other purposes, especially where electrical insulating values are important.

One very important war effort by the plastics industry is the export drive, for which purpose an Export Group has been formed, comprising the raw-material manufacturers, and another covering the moulders. The loss of certain promising European markets is to be regretted, due to the war developments of recent weeks, but other markets are closed to Germany and Italy, which give good scope to the British suppliers and can provide valuable "sinews" by way of exchange and the building up of goodwill.

It has not been the intention of this survey to touch on the more common and established uses of plastics in the war effort generally, most of which are too well known to merit repetition, but rather to indicate certain directions where it appears, to the writer at least, that full use is not yet being made of the possibilities which plastics as a whole offer as effective alternatives to products such as metal, wood, rubber, etc., which can thus be diverted for use in other directions which the plastic products, so far as they are developed at present, cannot hope to touch. Some of the possibilities must undoubtedly remain possibilities only for some time to come on account of there being no time to make the plant or to train workers in new methods of manufacture. On the other hand, there must be a considerable plant capacity existing within the industry itself which could be adapted or utilized to produce a wide range of plastic items for which at the moment valuable reserves of metal, etc., are being used, and the utilization of this capacity could render a very real and direct service to the country by the conservation of these more precious materials for other work.

It must, however, be borne in mind all the time that the plastics industry is very largely dependent on the tool-making industry. This applies to the use of the thermo-setting moulding compounds, such as phenolics and urea and, to a large extent, to the thermo-plastic materials, where the extrusion, compression or injection process has to be used. For certain sheet materials in the thermo-plastic sphere, simplified types of tools or former can, in certain directions, be effectively used, but it is probably safe to say that in at least nine cases out of 10 a special steel die is required for a new production, and although some of these dies are interchangeable between one plastic material and another, this does not hold good in every case. It follows that the extension of the use of plastics can go forward only at the pace at which the toolmakers, whether inside or outside the plastics industry, can produce the essential dies. The toolmaking industry has been working to capacity for a long time past, and it is an unavoidable fact that the training of a skilled toolmaker is of necessity a slow job. It is not the purpose of this article to suggest ways and means as to how this problem can best be tackled, but it does seem to indicate an increasingly close liaison between the industry and the Government, through appointed representatives, to tackle the problems involved, so that the country as a whole will not be prevented from reaping the fullest possible benefit from the constantly growing possibilities which plastics offer in aiding the war effort, both at home and in the export markets of the world which are still free from the Nazi and his imitators.

Plastics in Anæsthesia

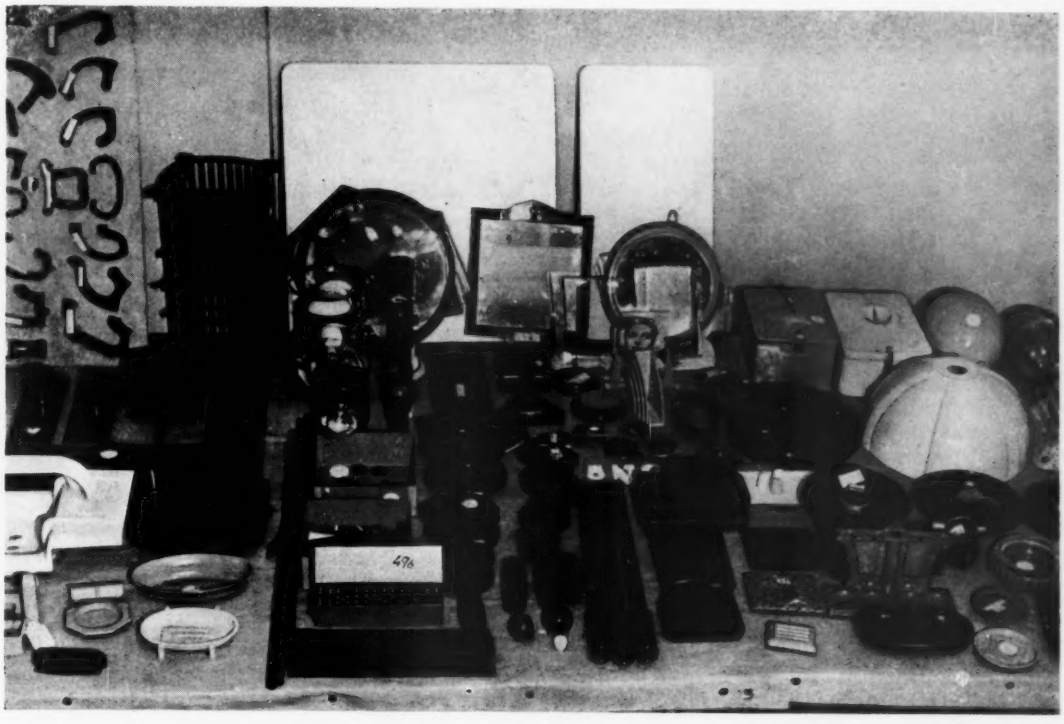
In our notes last month on the plastic bottle holders utilized in the anæsthetic apparatuses manufactured by Coxeter and Son, Ltd., of Morden Factory Estate, Morden Road, London, S.W.19, we omitted to mention that this concern is under the direct control of The British Oxygen Co., Ltd., Westminster, London, S.W.1. We should also like to add that all the photographs and details were published by kind permission of The British Oxygen Co., Ltd. As readers no doubt realize, this company is a very large manufacturer of compressed oxygen, liquid air, and many other industrial gases.

THE EXPORT GROUP

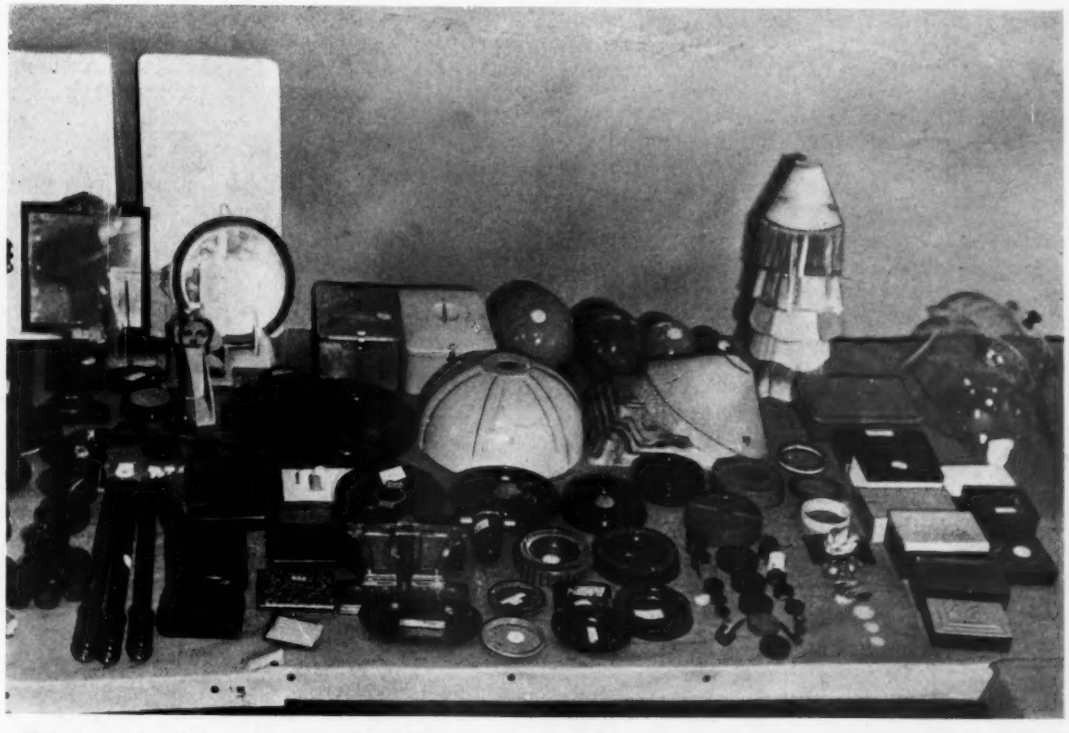
The Plastics Export Group, which has begun its first efforts strongly, displayed last week at the offices of the British Federation some 300 units. The photographs show trays, lavatory seats, bowls, vases, cups, saucers, plates, lemon squeezers, funnels, jam dishes, crumb collector, etc.

Table tops, door handles and finger plates, tea pot handles, etc., clothes hooks, stair-carpet fixtures, condiment containers, egg cups, candlesticks, powder bowls and other containers and a wide range of bathroom requisites, soap and razor cases.

DISPLAYS ITS WARES



Fire kerbs, mirror and picture frames, lamp holders, torch holders, clock faces and a host of sports articles, including fishing reels, fly boxes, extruded tubes for shrinking on golf clubs, cycle handles, gear knobs, cycle pumps, games, etc.

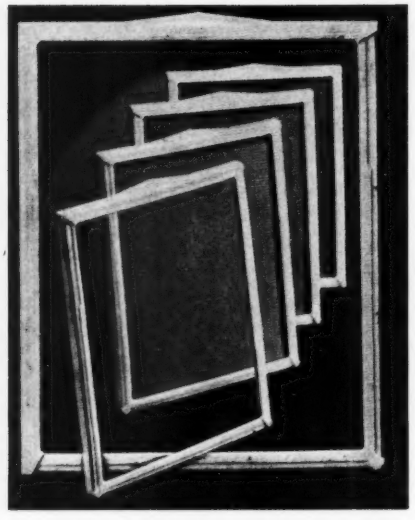


This section included a wide range of smokers' utility articles, pipe racks, cigar cases, a variety of ash trays, etc., many dress ornaments, bangles, boxes for many purposes, such as handkerchief containers, cigarette boxes, an excellent display of lamp shades and transparent acetate food covers.

REFLECTIONS ON FRAMES

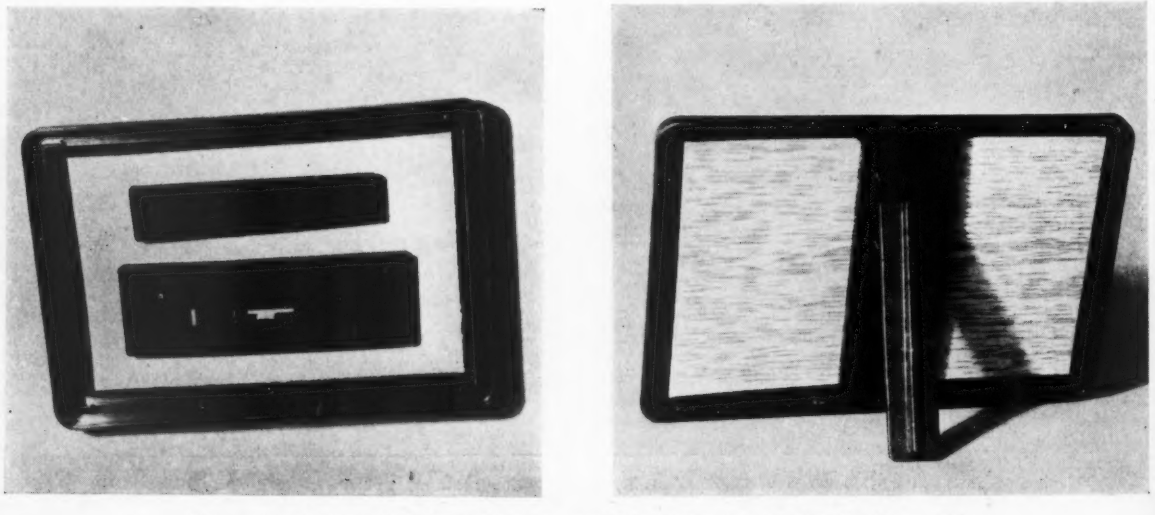
IN our June issue a reader inquired as to the possibilities of manufacturing picture frames from extruded phenolics, in order to avoid the use of wood. We replied that the idea was by no means new and, in addition, possessed certain inherent drawbacks which made the moulding of the entire frame by injection or compression more attractive. The extruded rod form must of necessity issue from the die either with a plain surface or with a "straight line design" parallel to the axis of the die, and although, no doubt, there is a good market for the plain, rectangular frame, yet it is obviously limited. The biggest drawback in the idea lies in the manner of fastening the four sides, and although, no doubt, a means could be devised to do this fairly efficiently, it would entail a considerable on-cost. With a thermo-plastic, the idea is more attractive, because of probable greater ease of assembly. We presume extrusion is regarded as promising because of the ability to make, within limits, any size frame from the extruded rod and so avoid costly moulds.

However this may be, it seems apparent that nobody has yet, within our knowledge, carried out the suggestion on a practical scale. The only processes employed are those of injection and compression moulding. The obvious advantages of the moulded frame over the extruded type are, first, that the former is made in one piece and does not suffer from becoming unstuck at the joints, and, secondly, that decoration of the surface during moulding is simple and is merely a function of the mould. The drawback of the moulded frame, or indeed any plastic frame, is that it is limited in size because of the limits of the press and because of the fact that plastics are about two or three times heavier than the common woods. Obviously, too, the moulded frame cannot be produced in a heterogeneity of sizes to satisfy the buyer of a frame to fit a picture. Consequently, the plastics industry restricts itself to the smaller sizes employed for pictures reproduced in large numbers and in limited sizes. In other words, the plastic picture frame is, in fact, a photograph or mirror frame.

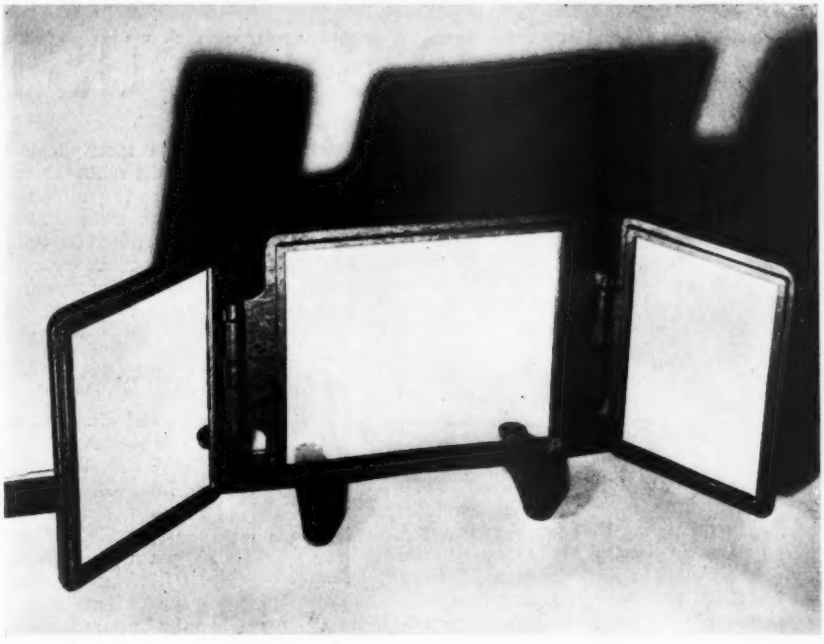


Tenite frames moulded by the injection process. (Courtesy of *Modern Plastics*.)

Nevertheless, there are ranges within these limits, as the photograph at the head of this page shows. These frames have been injection moulded from Tenite, the cellulose acetate produced by Tennessee Eastman Corporation of U.S.A., and moulded by the Gits Moulding Corporation. It is obvious that in such production a considerable saving, both in cost of making moulds and in actual time of production of mouldings, can be obtained by constructing one mould to contain two or more frames of different sizes by "concentric" design. This method of mould cost saving and moulding time is also shown in the photograph frame made by N.B. Mouldings, Limited; the three pieces—frame and two back units—are moulded in the same mould. It will be seen that, by ingenious design of the back units, the frame can stand "horizontally" or "vertically," according to the shape of the photograph.



Units and back view of photographic frame moulded of phenolics by N.B. Mouldings, Ltd.



"Triptych" mirrors and frames by N.B. Mouldings, Ltd., made for multiple-store sale.

An extremely interesting production of the frame type by this same concern is the "triptych" design of mirrors here reproduced. Here the design has allowed for the request for a triple mirror which can be sold as separate units.

It is to be hoped that the possibilities of plastics in this sphere will be so appreciated that such frames will retain the market long after the war has ended and when wood will no longer be a rare commodity.

A possible application of plastics in a similar field is that proposed to us by a director of a slate quarry. He has been asked to supply school slates, but finds the supply of wood for the frames almost non-existent. The usual sizes required are about 6 ins. by 8 ins. and 11 ins. by 8 ins. The main question is one of strength of material, for the slate probably weighs about ½ lb. to 1 lb. and falls are frequent. A fabric-filled powder would probably produce a strong enough frame.

THE PLASTIC AEROPLANE

As an additional note to our description of the Timm trainer, "the plastic aeroplane," which we published in our February, 1940, issue, we now have pleasure in showing the accompanying photograph of the machine in actual flight under testing conditions. The manner of production is still rather vague, but appears to be the moulding or, rather, shaping of resin-impregnated wood veneers under heat and pressure, using expanding rubber moulds heated by hot air. The wood is probably spruce impregnated with liquid phenolic resin. The resourceful American newspapers talk of it as "the first plastic plane, baked in an oven like a cake." They are not baked as quickly!

The Timm trainer in flight during trials. In aeronautical circles favourable comment has been made regarding its streamlined design.

WORLD'S INDUSTRIAL

SHIPBUILDING

Resin impregnated plywood is now being extensively employed for building all types of light craft. C. R. Simmons, in the May issue of *Modern Plastics*, gives some interesting data on this subject. After a good deal of experimental work, in which the resin impregnated plywood was used in watertight bulkheads and eventually for decking, seat brackets and mast hoops, many well-known boatbuilding concerns began using the new plywood in 1937 and 1938. The Cape Cod Shipbuilding Co. used it for decking and planking of their 10-ft. dinghy. Nevins, Consolidated, M. M. Davis, Wheeler, Owens began to use it for interior panelling, bulkheads, doors, partitions. Lawley-Mumford Co. are prominent users, having developed an 8-ft. rowing and sailing pram in 1937 which incorporated radically new construction features. This unit was planked with $\frac{3}{8}$-in. fir plywood, resin-bonded. Light aluminium alloy castings were used in place of the usual knees, frames, stem and other structural members. The entire weight of the pram was kept at 68 lb. It proved so popular and was so completely inexpensive to build that the company developed a 15-ft. featherweight centreboard sloop, utilizing the same type of construction and planked and decked with plywood. This boat weighed from approximately 150 to 200 lb. less than one built in the conventional manner. In addition to meeting the rigid tests of boatbuilders, the new phenolic bonded plywood brings many advantages. It is not lower in actual cost than plain lumber in the same woods, but there's a complementary saving in labour costs. Further, there's practically no waste from inferior stock. There's a huge saving in weight, as has been pointed out in the two specific cases mentioned. Yet there is no sacrifice in strength. In fact, for the same weight there's greater strength. Due to the construction of plywood it will not split easily—the cross-graining giving it great resistance —a characteristic which must be achieved with double planking when ordinary lumber is used. The bond between the plies is so strong that an attempt to split the plywood at the glue line is no more successful than at any other point. Contraction and expansion of this plywood is almost negligible. Consequently, in many cases caulking is unnecessary. The phenolic resin bond has been proved definitely to retard and almost completely stop termite and fungus growth. It inhibits dry rot. Even the rats seem to stop at the glue line.

AGRICULTURE

Plastics from farm products now assuming great importance in America, where there is a large surplus of cellulose, corn, starch, soybean and other fruits of the soil. Hydrolyzed wood (that is, sawdust or chips partially processed in the plastics process) makes an excellent filler for use in the production of phenolic resins. Plastics of this type have a greater flow with hydrolyzed wood than with wood-flour filler and a greater moisture resistance: 25 to 30 per cent. more hydrolyzed wood than wood flour can be used; it is estimated that by this means a saving of one or two cents per pound can be effected in the production of a filled Bakelite moulding powder. Another interesting production is a leather finish made possible by the use of a suspension or dispersion of soybean meal in formaldehyde solution, which, upon evaporation of the water, yields a hardened protein possessing increased water resistance. It has been found to be particularly important as a leather finish, because of its mildly acid character, increased water resistance and flexibility. Also it has been used to produce from kraft paper a cheap, laminated board possessing high strength and having a potential outlet in the form of wallboard and similar building material.

GENERAL ENGINEERING

Rubber - metal bond announced by the Hewitt Rubber Corp., Buffalo, U.S.A., makes possible a method for bonding soft rubber and neoprene to steel and aluminium by means of hot vulcanization. The new process, which is to be known as Dura-Bond, is said to yield exceptionally high adhesion strength with remarkably high ageing qualities, and adhesion strengths of 500 to 750 lb. per sq. in. are said to have been obtained. The bond is recommended for service temperatures up to 200 degrees Fahrenheit, although work is continuing with the aim of extending the range much higher. Dura-Bond modifies the rubber chemically in such a way as to permit vulcanization both to the metal and to the outer rubber layer. It is being used for producing rubber-covered rollers and cylinders and for attaching hose to metal nipples.

BUILDING

Melamine resins manufactured by the Beetle Products Division of the American Cynamid Company, N.Y., U.S.A., from cynamid, are now being used in the production of laminated sheet material. It is claimed that as this is highly resistant to abrasion as well as to hot and cold water, solvents, fats and dilute acids and alkalis, the laminated sheet will probably be widely used for lining refrigerator cabinets. Whether the new material will be made up entirely of "Melamine" resin is not yet known, but the Westinghouse panels for refrigerators making use of the new plastic were made, initially at least, with a white "Melamine" coating over phenolic laminated sheet (Micarta). **Fluorescent laminated sheet** now being produced in America for architectural and other uses. D. J. O'Connor, president, Formica Insulation Company, at a Franklin Institute meeting recently held in Philadelphia, showed a number of panels treated with fluorescent materials when irradiated by means of standard U.V. lamps. Panels of laminated material, which incorporate fluorescent dyes and pigments, have to be viewed in the dark and glow mysteriously only when subjected to the invisible or so-called "black light" emitted by a mercury vapour or quartz lamp. The design prepared on the panel can be made to glow in different colours, depending, of course, upon the type of pigments used. It is considered probable that these new panels will find interesting mural applications in cinemas, restaurants and large stores where the novelty angle has continually to be stressed. They are also likely to be used in sign making and also for shop fittings and displays. **Bonding of plastics to metal** surfaces offers new decorative and utilitarian opportunities to the architect and builder. A new vinyl resin, in which the main component is vinylidene chloride, adheres with exceptional tenacity

RMPLOYS PLASTICS

when heat-bonded to smooth metal surfaces, if it is blended with a high proportion of a fibrous non-thermo-plastic filler. Unfilled polyvinylidene chloride alone does not possess the necessary high adhesive properties. Useful fillers include asbestos and sisal, hemp and short staple cotton. The bond is not broken by hammering, bending or the action of common solvents or chemicals. The fibre-containing layer can serve as a foundation for a second layer of the same copolymer from which the filler is omitted, and in which pigments or metal powders may be incorporated for decorative purposes. **Cellulose acetate shelf edging** announced by a well-known concern in America. The Celomat Co., New York, U.S.A., is now offering Plastacele cellulose acetate shelf edging with pastel patterns painted or printed on the back of the transparent material. **Extruded plastics** finding increasing uses for interior decoration in America. The material used is Tennessee Eastman cellulose butyrate known as Tenite II. Detroit Macoid Corp., Detroit, Mich., U.S.A., is developing many new applications, particularly where colour in combination with metal is desired.

AIRCRAFT

Nylon for parachutes is mentioned in the June issue of *Aeronautics* as a possible substitute for silk. Experiments carried out in the United States have, it is stated, shown that various forms of cellulose fibres possess interesting possibilities, although, up to the present time, no synthetic fibre has been produced which can equal silk for strength at a given weight, but a fabric made with a new acetate fibre has given promising results, and experimental parachutes with this material are now being tried out. Acetate rayon has a "wet strength" which is higher than other rayons. Nylon and Vinyon are less affected by acids and alkalis than silk, and after experiments at Wright Field by the U.S. Air Corps, it is likely that they will be used for a number of purposes, such as webbing, insulation fabrics, lining materials and suspension lines. **Acetate in British aircraft construction** is the subject of an article by S. H. Miller in the June issue of *Aeronautics*. The writer states that some 200 different parts are made from acetate sheet. Components now made of this thermo-plastic include main and tail plane root fillets, air intakes for oil cooling and cockpit heating, gun heating outlets for foul air, general ventilating systems, footholds and handholds, dinghy storage, wheel spats and undercarriage trousers, strut end fairings, cover plates over engine and other controls, all sorts of blisters, rudder bottoms and fronts, rear portions of fins, retractable tail wheel fairing, electrical wiring conduit switch and fusebox and covers, enclosed main control channels, camera shields, wing pressure and water exclusion valves, directional aerial covers, aerial mast leads, trailing mast leads, trailing aerial tubes and complete detachable wing clips. All these and many others have done the job as well as it can be done and so saved metal.

MISCELLANEOUS

Latex as an adhesive agent now assuming considerable importance, and recent American patents, U.S.P. 2,187,743 and U.S.P. 2,188,283, describe several interesting applications. In the case of the first-named patent, which deals with abrasive wheels, it is an advantage if the abrasive-coated discs are capable of withstanding repeated flexing without cracking. This is particularly the case when cleaning out channels or corners of metal structures, as in the finishing or polishing of motorcar bodies. Heavy fabric backings for abrasive granule-coated discs are satisfactory for many purposes, but fail to give satisfaction under the more exacting conditions. One proposed method of overcoming the difficulty is to use a backing of thin metal sheet and to bond it to the abrasive disc with the aid of rubber latex. The latter is found to be an exceptionally strong and durable adhesive under hard-wearing conditions. A sheet of sand-blasted spring steel, thickness 0.032 in., is coated with a thin film of latex on one side and the uncoated side of the granule (e.g., carborundum) coated fabric or paper is forced into contact with the aid of a soft rubber roller and kept in firm contact until the latex has dried. Discs of any size can be cut or stamped out from the sheet without the adhesion being broken. U.S.P. 2,188,283 deals with rayon cord tyres. Cotton fibres are covered with a fine down which naturally assists the adhesion to the rubber in course of tyre manufacture. Rayon filaments possess a relatively smooth surface. Twisted fibres become more firmly anchored, but rayon cannot be twisted to the same degree as cotton without loss of strength. When using rayon in place of cotton for incorporation in the casings of pneumatic tyres, it has consequently been found advisable to reinforce the bond between rubber and rayon with the aid of an adhesive. A particularly effective composition for this purpose appears to be a mixture of a protein (casein, gelatine, etc.) and rubber latex. A typical composition, obtained by blending a ball-milled solution of casein in dilute ammonia with commercial latex, might contain 5 per cent. casein, 12.5 per cent. rubber, 3 per cent. ammonium hydroxide, and 79.5 per cent. water. The casein has the further advantage of promoting penetration, and rayon cords are sufficiently impregnated after dipping for only 30 seconds. Drying must be carried out with care to avoid blistering. Prior to processing with the rubber component of the tyres, the cords are preferably reheated for a few minutes at 250 degrees F. in order to bring the moisture content down to a uniformly low and stable level. **Rubber moulds** are now extensively employed for casting plaster or plastics. Rubber moulds were first used in the manufacture of novelty jewellery, the plastic material being used either hot or cold. The technique has now been improved to such a point that statues of considerable size can be cast in this manner. Rubber moulds possess special advantages, most important of which are their durability and ease in handling. Preparation of the moulds, especially in the case of smaller objects, is very simple, provided the proper type of latex compound is used. After the mould has once been made, a large number of objects may be cast from it, provided a suitable degree of care is used and that it is not subjected to temperatures much over 200 degrees F. The latex compound usually has a high solids content and such a consistency that it may be sprayed or brushed on the form, or preferably that the form or model may be dipped in it. If the size of the object is such that it may be dipped in the latex, less difficulty is experienced with air bubbles than is the case when spraying or brushing. After the model has been coated it is dried in warm air and the dipping repeated until sufficient wall thickness has been built up. The mould is then thoroughly dried and vulcanized. It will generally be necessary to form a plaster backing or other rigid support for the mould. Since the rubber is flexible, the material cast in it will tend to cause some deformation unless such backing is used.

Interesting Rolls Moulding

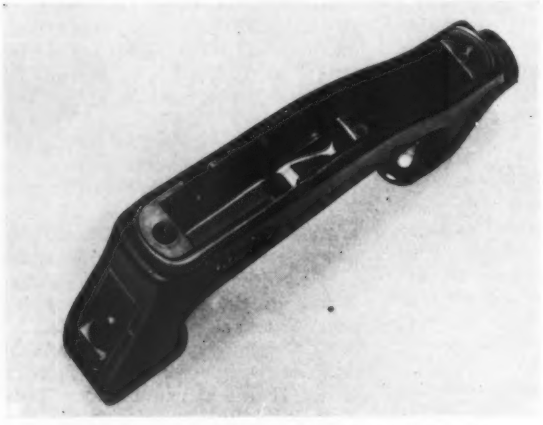
THE moulding shown in the photograph is a good example of the complicated designs now being produced in phenol-formaldehyde resins. This particular example was moulded by Rolls Razor, Ltd., for Hoover, Ltd. A glance at the moulding will show that with no other material would it have been possible to produce such a shape in one single operation. Whilst the same design could be produced in the form of a metal diecasting, this would have required some kind of finishing to make it at all comparable with the moulding. Briefly, the advantages of this moulded handle are as follows:—

Smart appearance and good wearing properties.

High dielectric strength of the material, which facilitates wiring.

Easy and accurate fitting to the body of the machine by means of the screw holes.

Lightness in weight, which, of course, means greater convenience and ease of handling.



Close-up of the moulded Bakelite handle for the Hoover Dustette domestic appliance. This handle is moulded by Rolls Razor, Ltd., Cricklewood Broadway, London, N.W.2.

New Water Soluble Vinyl Resins

A NEW group of water soluble, water dispersible vinyl resins which can be moulded, extruded or formed into sheets, is announced by E. I. du Pont de Nemours and Co.

The resins are described as polyvinyl alcohols and have been designated as PVA. Properties suggest an extraordinarily wide range of industrial possibilities. A hard tough plastic may be obtained by heating in a mould under pressure. If plasticized before moulding, rubber-like products of extreme elasticity and flexibility are said to result. Various plasticizers and grades of the resins will produce any desired degree of softness.

The resins display characteristic resistance to the action of oils, fats and most organic solvents, including chlorohydrocarbons, aromatic hydrocarbons, carbon disulphide, alcohols, esters, ethers or ketones. They are resistant to the action of oxygen, ozone and to deterioration caused by vibration and flexing. PVA is free from sulphur and its films possess a high degree of impermeability to gases such as hydrogen, hydrogen sulphide, etc., it is said.

Polyvinyl alcohol sheeting, or glass coated with it, provides windows which are not only rendered safer against shattering but which will not fog under conditions of high humidity inside a room and low temperature outside. Such a composition can be used on automobile windshields and on windows for gas masks. In some cases, depending on the nature and composition of the article to be moulded, the ordinary flash type of mould as used in the rubber industry can be employed. In other cases, positive pressure types are recommended. Moulds often can be packed with the plasticized PVA powder, while in other cases it is better to use a preformed sheet made either by pressing the powder in a mould or by milling the plasticized powder. Various fillers can be added to the moulding composition during milling if desired.

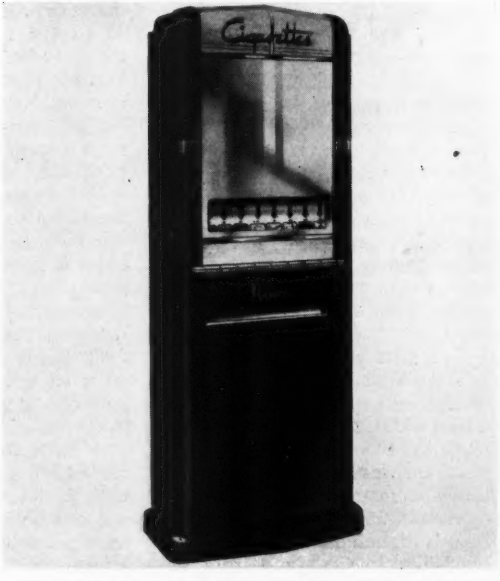
Plasticized PVA compositions are extruded in the form of tubes, rods, sheets and threads. Tubing and hose are now commercially available. Tubing is extruded by methods similar to those used in making rubber tubing.

The plain, unpigmented tubing is transparent and almost colourless. It has low specific gravity, high tensile strength and high abrasion resistance at low temperatures. The tubing is claimed also to have remarkable ability to transmit speech and other sound, with minimum distortion and little absorption by the tube wall. Application in dictating machines and sound equipment is expected.

The resins are manufactured in a number of grades, since proper selection is necessary to meet individual requirements. In general, polyvinyl alcohols are white to creamy white powders, odourless and tasteless. No toxic or inflammable solvents need be employed, and, if desirable, the film can be made waterproof.

Plastics for Slot Machines

THE well-known Rowe de Luxe slot machines combine two Monsanto plastics in a sales-promoting design. Cast phenolic, in creamy onyx, forms the top panels and bar across the bottom of the mirror. These panels may be illuminated to throw a soft, pleasing glow. The lettering, coin slots and pull grips are injection-moulded of lustrous, non-scratching cellulose acetate.



This photograph of the new Rowe slot machine shows the main exterior application of plastics. The machine is designed for cigarettes or sweets.

Metal Adhesion with Plastics

Some Notes on the Cellon Metal Strip Sealing Process

ADHESION of metal sheet to metal sheet has never, we believe, been utilized in engineering—we do not include tin plating, metal spraying, etc., in this category. Although there are processes where thin metal sheet is made to adhere by means of organic adhesives to metal and other bases, e.g., the application of beaten gold, they are restricted to the decorative industries.

The process to be described—a method of securing metal strip to a metal structure—is as unique as it is intelligent in conception, and although at present it is most widely used in aircraft construction, yet it seems evident that the applications are much wider and can include the covering with metal strip of jointings of constructional material in general.

To us the main interest lies in the fact that a plastic material (a thermo-plastic one) is employed as the bonding material.

As indicated above, the Cellon Metal Strip Sealing Process has been developed primarily in connection with aircraft construction and finishing where aerodynamically smooth surfaces are of the first importance and where emerging heads of rivets and those of the hollow type are danger points from the point of view of moisture and dirt collection and subsequent corrosion. It is well known, in addition, that when rivets are uncovered they create so great a resistance as to reduce the speed of the aircraft considerably.

The normal procedure of treating rivet holes, dents, etc., before the advent of the Cellon process has been to treat them by the well-known methods of stopping and by coating heavily with fillers prior to the application of the finishing coats. The drawbacks to these were many. Such stoppings were (a) liable to crack, since they lacked both flexibility and real adhesion and introduced corrosion at the joint; (b) the weight of stoppers was considerable, and (c) the time and labour involved in their application was great.

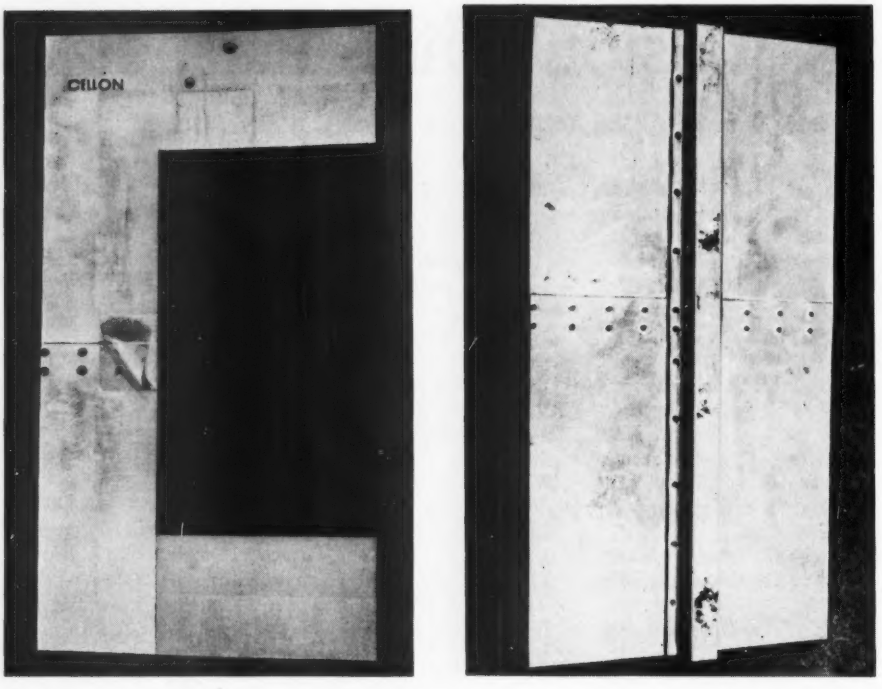
The Cellon process eliminates all these disadvantages in an extremely simple and rapid manner. It consists essentially in securing a strip of light metal, generally aluminium, one side of which is coated with a thermo-plastic, to the surface which it is desired to smooth.

The strip in roll form is first prepared by spreading or spraying on to it a solution of thermo-plastic resin and allowing the latter to dry. The thermo-plastic employed may be nitro-cellulose, glyptal, vinyl or acrylic-acid resin.

The method of application is as follows. The surface to be treated is first freed from grease and is then given a coating of adhesive similar in composition to that applied on the metal strip and allowed to harden off. The foil is then placed in position and low heat and light pressure is applied by means, preferably, of a thermostatically controlled iron in a manner similar to that of domestic ironing. The temperature of the iron, which is specially shaped for the work, is maintained at 115 degrees C., so that no harm is caused to the structure of certain light alloys. Once the iron has left the surface the strip cools down quickly by conduction and is then quite secure. It becomes evident that the use of a thermo-plastic resin adhesive is of special interest here, since the strip can, if necessary, be prised off the surface for inspection purposes and again be securely sealed down by means of the hot iron. Such a procedure is often desired with inspection covers, which can thus be rendered corrosion and waterproof.

Since the strip usually employed for covering overlaps and rivets is extremely thin (4/1000 in.), only one or two coats of primer are required to make level.

Sealing a riveted joint by the Cellon process with aluminium strip coated with thermo-plastic.



Front and back view of jointed and "stayed" aluminium structure. The edge of the horizontal adherent strip has been lifted for examination. The black rectangle is the overall final coloured coating.

It may be noted at this point that the adhesive is supplied in two forms, one in which metallic chromates, such as zinc chromate, are incorporated into the adhesive solution to impart anti-corrosive properties to the metal, and a second in which the chromates are excluded. The second solution is obviously employed where no corrosion is encountered.

The Cellon process thus provides a combination for completely sealing a metal structure and, at the same time, making the joint quite corrosion-proof. With regard to leakage in enclosed aircraft structures, it is common knowledge that aeroplane wings have sometimes been found to be part full of rain-water after standing on the aerodrome for some days, while corrosion, as a consequence, has been serious. In contradistinction, the new process has been tested with illuminating results. Various immersion tests have been carried out by immersing sealed floats in both river and sea water for periods of four-six months. These have shown the adhesive to be quite unaffected and the metallic surface beneath the sealing foil perfectly protected. Joints of petrol and paraffin tanks which have been sealed outside with this process have remained liquid tight for over long periods.

Many well-known aircraft constructors now incorporate the process in their designs, but other industries are interested and constructors of railway and other transport vehicles are finding that steel and aluminium joints may be covered efficiently and simply, thus eliminating the use of beadings to yield flush joints, which are more readily cleaned and more quickly painted. Already the strip process is being employed for sealing roof panel joints on motorbuses, where flush, leak-proof surfaces are required.

To sum up, the following are the advantages of the process:—

(1) Gives greater protection against corrosion at vulnerable points, such as rivet heads, overlaps, etc.

(2) Eliminates cracking, which is inevitable with heavily stopped or filled surfaces, especially under vibration and stressed conditions.

(3) Can be applied far more quickly than hand-stopping methods.

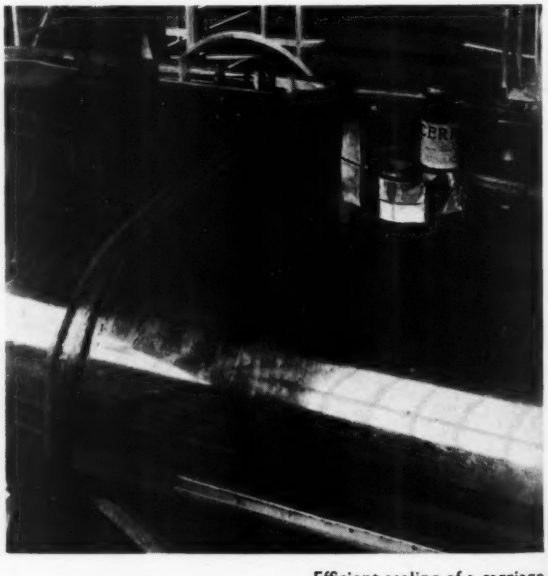
(4) Saves weight over similar filled or stopped-up surfaces.

(5) Resists water, petrol, oil and other solvents.

(6) Can be employed for preparing liquid or gas-tight joints.

(7) Adhesive is thermo-plastic and permanent.

The process, too, may prove of some use to the plastics industry. We have long advocated the introduction of metal designs on plastic surfaces to improve the latter for certain decorative advantages. It does not seem without the bounds of possibility that the Cellon strip process has in it the germ of application in this respect.



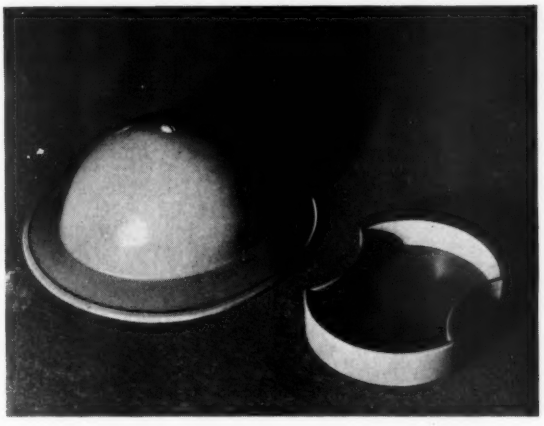
Efficient sealing of a carriage roof by the strip process.

Ideas—

By the EDITOR

Plastic Helmets

Although the Ministry of Supply has never been much impressed by my almost tearful insistence that some use should be made of high shock plastics for the production of A.R.P., A.F.S., and policemen's helmets to protect them during air raids, I am delighted to note that many thousands of moulded helmets are, in fact, being produced by Rootes Mouldings, Ltd., of Slough, for the well-known perfume



firm of Delavelle. They are, perhaps, rather smaller than the original idea, but, fortunately, are much prettier. At least we can congratulate ourselves that the idea is not lost to posterity. The helmets are made in two colours—one khaki and the other dark blue—and they are about 3½ ins. at their widest diameter. A second moulded unit, which fits inside the helmet, holds the bottle of scent. I do hope that Delavelle's will be able to continue with similar ideas during the difficult times ahead.

An Old Idea

I am not resuscitating the following because I have run out of new ideas, although this is almost true in these dog days and rather worried times when the brain almost stands still and refuses to work properly. It is because I am always very keen indeed to show potential users of plastics that this industry of ours is based on very sound foundations, that plastics, when their use is conceived properly, when the raw materials are carefully chosen, and when the finished article is made properly, can prove to be excellent materials of construction, worthy to be considered with, and often superior to, the older substances, such as metal, wood, leather, etc. The method I like best to show this, and I believe it to be not only sound but attractive to the potential user of any raw material, is to describe how it has stood up to the test of time. In fact, we all know how loth the British buyer is to change his methods and how his first reaction to a new machine or almost anything new is: "Yes, that's all very fine and large and pretty, but I want to see who's using it already."

Well, I have adopted the method on occasion with some success, the last occasion being when I spoke of the Vent-Axia fan. This time it is on the Kalamazoo ledger binder.

Over three years ago I visited Kalamazoo, Ltd., to see an old acquaintance of mine, the chief chemist, Mr. A. G. Rendall. He showed me the new ledger cover they were making, utilizing a Bakelite laminated "sandwich in which rubber was the meat" he called it. Our readers may remember that we described its manufacture in our July, 1937, issue. I was extremely intrigued with the new cover, and although the testing by tumbling at the works is extremely severe and seemed to indicate a very long life, yet I was anxious to see how it really stood up to time and handling by the actual user. To this end I wrote a couple of weeks ago to Mr. Rendall and have received the following reply.

He first reminds me that "the rubber projecting from the fore edges is not a 'tyre' or a 'binding,' but is integral with the rest of the rubber, forming (with the Bakelite sheet) under heat and pressure a resilient, durable, and handsome material, which is simply ideal for the purpose for which we use it. During the past four years we have sold tens of thousands of this model. The binders are now used all over the world, and among our users are the largest banking organizations, Government authorities, and industrial concerns. Many of the binders—as you can well imagine—get

very rough treatment, banged, as they are, each night and morning to and from safes and trolleys. In spite of this treatment there has been *no case* where these plastic binder covers of ours failed to stand up to the demands made upon them."

There is no need to add anything to this statement. We do not know who first conceived this ingenious combination of two different raw materials. There must be many other applications for it and similar ones if we look deep enough. Since the plastic sheet is fungus and insect-proof, such covers must be of inestimable value in the tropics. These fields have scarcely been examined as a market for book covers.

PRODUCTION

Practical Information dealing with Raw Materials, Moulding and Forming of all types of Plastics—Thermo-Hardening and Thermo-Plastic—Works-Organization, New Plant and Control Apparatus

NOTES AND COMMENTS

Speed of Production

PROPERLY organized, the plastics industry is capable of such high production that it behoves the Government to regard it as one of the most important assets of the country. Were there in existence a band of advisers to tell manufacturers where to use plastics in place of metal, there would be not only an enormous saving of metal, but a real speed-up in production. Moreover, a proper reorientation of workers would shift some of those producing metal units which can be replaced by plastics to the production of essential metal units which plastics cannot replace.

We do not state that the speed of production of plastics is as high as that reached in the turning out of screws or punching small metal parts. But it is extremely high and, moreover, can turn out complicated shapes at a speed which metal working often cannot hope to emulate.

One American concern states that from one injection moulding press it can turn out 125,000 pieces per day. If we analyse this statement in greater detail on a basis of an eight-hour day, we find that this means the machine is turning out about 40 pieces at every injection, taking 10 secs. as a cycle. It may be that the press is a 40 impression mould turning out very small objects or, alternatively, the press may be working 24 hours.

More generally we should say that production figures for the fully automatic type of injection machine, counting the use of variety of moulds of 1 to 10 impressions, stoppages, finishing, etc., to be somewhere between 2,000 to 20,000 per day of eight hours. It has been stated that there are some 150 to 200 injection machines in this country. While these may include the hand type, the theoretical potential output for a 24-hour day is somewhere in the region of 1,000,000 to 10,000,000 units a day.

If we turn to the compression moulding industry, which consumes far more raw material than the injection press industry but produces the finished goods at a much lower rate, the figures are again enlightening. If we take one press it is probable that the average production is of the order of 600 to 6,000 units per 24-hour day. How many presses there are in the country is unknown, at least to us, but if we presume there are 1,500 presses (there should be at least this number) then the potential production figures are of the order of 900,000 to 9,000,000 pieces per 24-hour day.

Our object in reproducing these figures is not merely to stagger the imagination. We want the Government to know what the capacity of the industry is and to make use of it accordingly. A goodly number of plastic moulding factories are working hard—at a 24-hour day. At the other end of the scale are factories, generally small ones, whose presses are working at a fraction of their capacity only and have waited for Government or indirect Government contracts in vain.

Women Moulders

The remarks of Government officials recently regarding the employment of women on lathes and other machines have interested plastic moulders greatly. In the past the impact of women labour in the industry was indicated only in the examining and finishing rooms, which were "manned" entirely by women. To some extent, also, they were employed on injection moulding machines, where they are, for general purposes, although not for repairing stoppages and placing moulds, of great worth.

Some moulders have now tested out employing women on "compression" presses and have come to the conclusion that the experiment is not very successful.

Although women are much lighter-handed than men and on the small jobs should prove adequate, yet on the larger jobs the unloading operations need considerably more muscular and continuous effort than is good for them. Added to which, the heat at the press can be supported with greater ease by men.

Industrial Pamphlets

Bakelite Laminated. Those who have found value in previous technical literature issued by Bakelite, Ltd., such as "Bakelite for Silent Gears and Pinions," will find equally important data in a wider field in this the latest issue of the company. Following a description of the properties of Bakelite Laminated in general and of the four constituent types, paper laminated, fabric laminated, asbestos laminated and laminated plastics, the pamphlet describes their uses, the sizes available, and the directions for machining and otherwise working of each.

Synthetic Cements for Wood and Resins for Lacquers. These are two entirely new pamphlets issued by Beetle Products, Ltd., beautifully reproduced and illustrated by means of very interesting photographs. The first deals with the new Beetle Cements that have become so important to the aircraft industry. Their uses and methods of application are described in detail. The second pamphlet deals with the application of Beetle Resins in formulating heat-resisting finishes.

Inquiries and Answers

(In Which is Included General Correspondence)

Plastic Wash Basins

Southampton.

The Editor, *Plastics*.

Dear Sir,—We shall be pleased to know whether you can put us in touch with manufacturers of aircraft-type wash basins made of plastic material.

THE BRITISH POWER BOAT CO., LTD.

[EDITOR'S NOTE.—We do not know of any manufacturer producing wash basins of this type. We believe they are usually stamped out of aluminium. We should say that plastic wash basins would be quite satisfactory in urea or phenolic mouldings or even in acetate, if care were taken in their maintenance and dried reasonably well after washing. The phenolic mouldings would be somewhat darker than the urea type, but we cannot conceive this to be a serious drawback in aircraft. Even though these plastics have what is generally called a water absorption, yet this would be negligible if care were taken. The chief problem is the number required, unless price is of no consequence. The shape required is generally triangular to fit a corner.]

Plastic Moulds

Huntingdon.

The Editor, *Plastics*.

Dear Sir,—Could you tell me if it is practicable to produce a plastic mould that could be used to replace a steel or white-metal mould in the rubber industry? As an example, a steel mould to produce, say, light pairs of rubber heels is about £75, and, of course, there is also the shortage of steel. The general method employed for the production of soles and heels is the use of a cast box, with the pattern run in white metal. The objection to white metal is its short life, due largely to the surface becoming easily marked or scratched, especially if the operator is careless.

The requirements of a plastic mould briefly would be: Thickness, say, ¾ in., with the pattern countersunk, fairly strong enough to screw or dowel on to plates, withstand press cure of 60 lb. to 75 lb. steam and 1 ton per sq. in. on the press ram.

Have plastics been used to replace steel moulds?

F. W. HAWKINS.

[EDITOR'S NOTE.—The first approach to moulds made from a plastic material, so far as our information goes, is that given in our notes regarding Jabroc on p. 117 of our May issue. The example given could not be described as an ordinary mould, but rather as a former for shaping steel or other metal sheet. Apparently the material, which is composed of resin impregnated wood veneers consolidated into a block and then machined, is highly successful for the purpose. For the production of heels it must be remembered that such a plastic mould should be made simply, without sharp angles and without any complicated pattern. No doubt such a mould would be cheaper than the metal mould, but we have no information as to how it would stand up continuously to the temperature indicated, that is, about 150 degrees-160 degrees C. Normally most of the thermo-setting types of resin stand up to this temperature (170 degrees C. is the usual figure for wood-filled resins), but the above is a somewhat different material. Information on this point might be obtained from Moulded Components (Jablo), Ltd., Brettenham House, Strand, London, W.C.2, or the New Insulation Co., Ltd., of Bristol Road, Gloucester, who make a similar material, Permali.

It is, of course, possible to make a mould of plastics by compression moulding from the powder. Obviously a steel die would have to be used in the first place and a special heat-resisting plastic material could be employed, but at first sight this is scarcely an economical method, even though a large number could be made from the one metal mould. The compressive strength of these moulded types is over 8 tons per sq. in.]

Moulded Rod

1, Handel Parade,
Whitchurch Lane,
Edgware, Middx.

The Editor, *Plastics*.

Dear Sir,—We enclose a small sample of synthetic moulded rod, and as we understand that this is now manufactured in this country, we are wondering whether you can supply us with the name of the firm.

BRITISH-COLONIAL TRADING CO., LTD.

[EDITOR'S NOTE.—The sample sent is a piece of black rod about ⅜ in. diameter. Judging from a simple test it has been moulded from phenolic moulding powder. Judging also from the quality of the surface and the markings of two flashes, it has been produced in a simple type of compression mould and not by extrusion. Will the moulder please communicate directly with the inquirers, who are electrical and general engineers' furnishers? Alternatively, other manufacturers, such as those of rods of laminated materials, etc., might care to write.]

Resin Grinding

Blackpool.

The Editor, *Plastics*.

Dear Sir,—We have several tons of very hard resin which we require grinding to a fine powder, and are wondering if you could possibly give us the names of any firms who would undertake this work for us.

THE ORALITE CO., LTD.

[EDITOR'S NOTE.—The only concern we know that specializes in "grinding for the trade" is Thomas Hill-Jones, Ltd., Invicta Works, Bow Common Lane, London, E.3. Doubtless there are such workers in Lancashire and inquiries might be made to the British Chemical Plant Manufacturers Association, 166, Piccadilly, London, W.1. Resin grinding is a specialized job and it might be worth while getting in touch with manufacturers of resin grinding plant, such as Steele and Cowlishaw, Cooper Street, Hanley, Stoke-on-Trent; William Gardner and Sons (Gloucester), Ltd., Bristol Road, Gloucester; and J. Booth and Son, Congleton, Cheshire, who may have more precise information. In these difficult times, it is conceivable that gramophone record manufacturers, who are generally also experts in resin grinding, could be induced to carry out this work, but their grinding plants are usually very large and the grinding of a few tons may not be worth while.]

Note: If replies by post are required a stamped addressed envelope must be enclosed.

PULP, PAPER AND PLASTICS (Contd.)

By Julius Grant, M.Sc., Ph.D., F.I.C.

In the two previous issues of this journal the author dealt with the nature and manufacture of paper and pulp. The following and final article on this subject deals with surface-coated products, fibrous fillers for plastics and the treatment of paper pulp.

(3) Surface-coated Products

In the laminated and impregnated paper plastics dealt with hitherto, the individual fibres of the felted mat which constitutes the paper serves as a skeleton or reinforcement for a relatively large proportion of plastic. The coated type of paper plastic, however, may be regarded as a bridge between this type of paper plastic and the type which is primarily paper (rather than plastic), although certain of its properties are modified. Heavily coated papers overlap the former grade, and lightly coated papers the latter.

In the former, which represent one extreme, there is necessarily quite a good deal of penetration as well as mere surface treatment, and papers of this kind (e.g., treated with phenol-formaldehyde plastics) may be used for lamination. Their production and general properties have been outlined under the appropriate heading, and it will be recalled that whilst they compare very favourably with impregnated laminated plastics in respect of colour, they have a poorer water resistance. This is quite understandable, as penetration of plastic is less complete. Such papers develop a very glossy, oil-proof finish on the coated side, but they do not always machine cleanly and sometimes the laminations even come apart.

At the other extreme are papers which are lightly coated with plastic, possibly for decorative purposes or possibly for rendering the paper washable. Entirely different considerations, therefore, apply as compared with laminated products. The principal property demanded of the plastic is film-forming capacity and flexibility, whilst the paper must have a smooth finish and the power to support, rather than absorb, the film. The methods used are of three main types, i.e., the plastic may be applied directly in the molten state, as a solution or as an emulsion, and these will be dealt with in turn.

(a) *Direct Application.*—This method is the most difficult to operate successfully. Special plastic preparations are necessary, and these must be very viscous, even doughy, in consistency. They are applied in layers which are brought to the required thickness by means of a scraper-knife, which is adjustable so as to leave a variable clearance between it and the paper. The plastic must also be highly flexible, because the surface layer is relatively thick and cracking must be avoided. On the other hand, this high concentration of plastic on the surface of the paper is very effective in producing whatever special properties (e.g., moisture-resistance) which is desired of the paper.

An obvious aid to the operation of such processes is the use of a plastic which is molten at the high temperature at which it is applied to the paper, and which solidifies subsequently. The limitation here is the effect on the paper itself of the high temperatures frequently involved, but it has been possible to strike a compromise by the use of a combination of both heat and pressure. J. H. Long (*Tech. Assoc. Papers*, 1939, 22, 296) mentions that satisfactory results have been obtained in this way by the use of a plastic at 165 degrees C. and having a viscosity of 1 to 2 Saybolt-Furol units at this temperature. The difficulty of selecting a plastic having these somewhat specialized properties has been overcome partly, at any rate, by blending plastics with one another and/or with plasticizers. Ethyl cellulose (which is more heat-stable and blends better than the acetate or nitrate of cellulose) has proved to be a useful basis for such blends. Examples of suitable heat-stable plasticizers are the dibutyl and diphenyl phthalates, and even vegetable oils; the former type are, in a sense, non-volatile solvents for the plastic. Other resins which have proved suitable are described under the heading of the coated-laminating papers.

Long (loc. cit.) has determined the properties of treated papers of this type containing about 15 to 50 per cent. of plastic. The gloss value attained 70 per cent. of that obtained when the untreated paper was covered with plate glass; resistance to pressure-blocking at 50 degrees C. to fluffing and to creasing were very satisfactory, and resistance to moisture, though good, was insufficient to qualify for the rarely justifiable adjective of "waterproof." Advantage may be taken of the rapid rate of setting typical of certain plastic coatings to produce novel decorative effects. Thus, imitation suede is made by passing the coated paper through a chamber containing air-floated coloured-paper flocks, which settle on the paper before the coating solidifies.

(b) *Application as a Solution.*—Such methods differ from those already described in that they involve the use of a volatile solvent, and a solvent-recovery plant is almost always essential on economic grounds. In general, it is more difficult to obtain a large proportion of the plastic on the surface of the paper owing to the tendency of the solvent to carry the former into the paper before it evaporates. Careful selection of the solvent (which should evaporate fairly rapidly) and of paper (which should be as resistant as possible) are, therefore, necessary.

Many of the plastics already mentioned under the other headings may be used with solvents, especially if a suitable plasticizer is also included; this method is, in fact, applicable to a great variety of plastics. Ester gums, for example, are used, but are not entirely suitable owing to the low volatility of the solvents usually required. Another example is the alkyd resins, and in particular those which are unstable to heat. Oleic acid or castor oil is added to these to increase their water-resistance and flexibility and to enable cheaper solvents to be used, and "driers" serve to accelerate the rate of drying, one hour at 100 degrees C. being stated to be adequate to produce a dry film from a plastic containing over 50 per cent. of a phthalic glyceride (see S. S. Gutkin, *Paper Ind.*, 1935, 405).

Rosin-maleic anhydride plastics are a novel example of this type, since they are soluble in ammoniacal water and may be applied from this as a solvent; they are then made into an emulsion with paraffin if an increased water-resistant is desired. Greaseproof coatings are

made by treating the hardened oleo-resin with about 3 per cent. of zinc oxide during the cooking process (cf. S. S. Gutkin, loc. cit.). Maleic anhydride-rosin esters are, in general, more oil-resistant and harder than the ordinary rosin esters. Urea-formaldehyde plastics may also be applied as an aqueous syrup containing about 50 per cent. of the plastic.

(c) *Emulsion Coating.*—Reference has already been made to the use of emulsions as a means of applying plastic coatings to paper. The plastics which may be used in this way are restricted by the necessity that they should possess the property of emulsification; this restriction is, however, of less importance where emulsifying agents can be added to produce the same effects, and many plastics can be dealt with in this way. The advantages of emulsions are that if (as is usually the case) water is the medium, the cost and difficulties associated with volatile solvents are overcome, and yet a relatively thick surface layer may be obtained. The use of emulsions in water also facilitates the blending of plastics, while the characteristic fibrous structure of certain papers enables them to remove water by absorption and subsequent evaporation on the other side of the sheet, leaving a film of the plastic " high and dry " on the surface of application; in this way even the surface of the blotting paper may be treated. On the other hand, water dries relatively slowly compared with volatile solvents.

Emulsions may be applied mechanically to a continuous web of paper by spraying, brushing or dipping, etc., much as on an ordinary paper-coating machine. The method is varied according to the nature of the plastic and the thickness of the coating to be applied. Emulsion methods are usually regarded as solutions to particular problems, rather than as complete substitutes for the alternative methods described (cf. L. J. Smith, *Paper Ind.*, 1937, 455). Examples of their use are to improve existing finishes; to prepare paper surfaces or pulp for treatment with paint or varnish (e.g., for wallboards); and in the preparation of paper containers for oils, since a final coating of plastic is said to accelerate the rate of drainage of the oil when the container is emptied.

As already stated, many plastics may be emulsified with water, especially if an emulsifying agent is introduced. Special reference might, however, be made to the alkyd plastics which have been used as a substitute for casein in the preparation of ordinary coated papers, as well as an adhesive for other paper products Some of the thermo-plastic alkyd resins may be rendered partly water-soluble, and this is sometimes an advantage when they are used as substitutes for the sizing medium of ordinary paper coatings.

(4) Fibrous Fillers for Plastics

Here, again, paper (or, rather, to keep the treatment as general as possible, cellulose) is used in quantities which vary from 5 to 100 per cent. as a reinforcing agent for plastics, although it functions in an entirely different way. Instead of the plastic being deposited on the ready-made web of paper, the individual fine cellulose fibres are distributed into the plastic before it is set or moulded. In order to obtain a mixture which is as homogeneous as possible, it is often necessary to use comparatively short fibres, and it is not surprising that, other things being equal, the strength obtainable in this way is less than that which results when the plastic is deposited on long-felted fibres arranged in the relatively ordered manner known as paper. Moreover, the high temperatures used in moulding may impair the strength of the fibres, unless the plastic is selected accordingly. Comparisons of strength of these with some other types of paper plastics are given under the heading of laminated materials.

On the other hand, this method places no restriction on the shape of the article subsequently to be made, and mouldings of almost every shape can be reinforced in this way. Another advantage is that an operation is saved, the process of making a speciality paper being eliminated. Actually, these processes are not restricted to paper fibres. Baekland, in fact, who first devised the method, used wood flour, which has the advantage of providing cellulose in a very convenient form, and it has been used widely since. The lignins and other impurities which share (with about 50 per cent. of fibrous cellulose) the substance of wood flour have, however, a deleterious effect on the strength of the fibres. Wood flour, moreover, impairs the moulding properties of the powder less than does paper, although the latter has to be completely disintegrated so as to be reduced to the fibrous state—thereby reversing the paper-making operation. Cellulose pulp, on the other hand, disintegrates more readily and can be obtained in fibres of longer lengths than those of wood flour; combinations of wood-flour paper or pulp fibres are, therefore, also sometimes used. In spite of these facts, however, considerable strength values can be developed and some such products will even resist a blow from a hammer; as substitutes for certain types of more fragile materials (e.g., porcelain insulators) they are, therefore, invaluable.

In an interesting process which has recently been described (Mead Corpn., Samaras and Plunguian, *Brit. Pat.*, 476,344) the purified lignin from the spent digester liquor from the manufacture of wood pulp (cf. J. Grant, "Wood Pulp," loc. cit.) is mixed with water and/or furfural (to lower its melting point), 20 to 80 per cent. of a fibrous filler and a thermo-setting plastic (i.e., phenol- or urea-formaldehyde). After one hour of mixing the product is hot-milled to cause partial setting of the plastic and to melt the lignin, which thereby behaves as a binder; grinding and moulding then follow as usual.

(5) Treatment of Paper Pulp

This last method cannot be said to have progressed far beyond the experimental stage, but it has promising prospects in certain directions. The principle on which it is based is the addition of the plastic (or of the ingredients which eventually form the plastic) to the paper pulp before it is made into paper, e.g., during the beating operation described above. The object is to eliminate the treatment process after the paper is made as well as to ensure intimate contact between the plastic and the individual fibres.

In one such process (Richardson Co., *Brit. Pat.*, 424,098, 19.2.34), chemical wood or rag pulp is heated in water with a phenol-formaldehyde and a catalyst (e.g., ammonia or sodium carbonate) at 100 degrees C., and under a slight pressure. When the resulting resin has attained a heat-fusible, but non-adhesive condition, cold water is added to stop the reaction and the pulp is beaten lightly and made into paper. In another process of the same type (R. H. Kienle and W. J. Scheiber, *Can. Pat.*, 323,870, 5.7.32) an acid-soluble condensation product is added to the pulp and precipitated on the fibres by the action of alkali and heat. The beating and paper-making processes then follow. It is claimed

that such papers may be used directly for laminating without further impregnation.

The nature of the operation of paper making involves losses of some of the plastic, unless it is very firmly held on the fibres. This occurs when the diluted pulp runs on to the moving machine wire, through which the water (and, possibly, some of the plastic) drains, leaving a felt of paper fibres behind. Various devices exist for minimizing this trouble by increasing the adherence of the plastic to the fibre. Among these are the production of the plastic *in situ* by precipitation in the beater (see above), and the addition of starch and sizes, etc., which, it is presumed, coat the plastic-impregnated fibres. However, even if retention is increased other difficulties may occur, especially when the quantities of plastic added are relatively large, as is necessitated in certain instances (e.g., where the final paper is to be used for laminating). Such difficulties include blockage of the wire of the paper machine, with the result that the drainage rate is affected; and couching, pressing and drying troubles, especially if the plastic is at all tacky when it comes into contact with the hot drying cylinders or woollen felts used as supports. These, however, are mainly difficulties of a paper-making character and no doubt will be overcome when such processes have justified themselves in other ways.

An application of this nature which has met with more success is the use of plastics as sizing agents for paper. The principle and method of operation are the same as those already described, but as the quantities of plastic used are much smaller there is little or no loss or interference with drainage and drying, etc. The best dispersion of the plastic around the fibres is achieved by adding the former in an emulsified form (e.g., in water, with the aid of an emulsifier such as stearic acid or an alkali salt of a sulphonated aromatic acid), and phenol-aldehyde and coumarone plastics have been used in this way.

Synthetic Plastics and Fibres

AT a meeting of the Montreal Section of the Society of Chemical Industry recently Drs. Nichols and Larose read two valuable papers on the above subjects. The first author discussed the significance of the structure of resins in relation to their properties and showed how most resins consist of macromolecules—long, flexible, chain-like structures of high molecular weight. These exist in independent units or are bonded together in a tridimensional lattice, the structural units of such molecules numbering hundreds, or even thousands. Investigations point to the facts that 50 to 100 structural units are necessary to make resinous materials and that at least 100 are necessary to give fibre-forming properties. The formation of resins by polymerization and condensation allows for the production not only of long chains, but also the production of cross-linkages.

Tensile strength of resins is improved by orientation of the molecules along parallel axes—the chemical and physical forces thus having a maximum effect. The property of pliability or elasticity is related to the shape of the molecule: the helix formation resists attempted organization by an elastic force. Cross bonds between helices increase rigidity and decrease elasticity. The properties of resins are also affected by the type of "backbone" linkage and the substituent linkages. Thus, a carbon-to-carbon linkage imparts water resistance and dielectric strength. The substituent groupings in alkyd and polyamide resins render them less stable to strong alkalis; chlorine in polyvinyl chloride and in neoprene "rubber" renders them resistant to chemicals and the phenyl group in polystyrene makes for decreased elasticity.

Dr. Larose described the changes that had come over the textile industry in recent years. Formerly it had depended upon finishing material, such as starches, gums, waxes, etc., and mechanical processes, such as calendering, schreinering, etc. The desire to impart non-creasing and non-shrinking fabrics has led to new finishing materials which included synthetic resins—urea-formaldehyde, glyptals, acrylates and vinyl chloride or acetate.

These finishes are usually applied by a process of impregnation, assisted by wetting agents or by condensation of the resin on the fabric, as with urea-formaldehydes. This is followed by curing, washing, rinsing, drying and setting the resin at a high temperature. In particular cases rubber latex can be added to the resin solution.

It has been found that the use of resinous finishing materials also increases the strength of rayon fabric and decreases the tendency of staple fibres to fray. There is less damage on laundering, the fabric is weighted, slippage is reduced, as is shrinkage, and garments keep their shape better.

Other uses of resins include anti-shrinking, stiffening, stabilization of crimp, etc.

Dr. Larose then went on to discuss synthetic fibres, which were developed in the attempt to emulate and improve on natural materials, such as proteins, cellulose and rubber. In using resins as fibres it must be borne in mind that some properties are associated with, and belong to, the fibres as a whole, but that others are molecular. Synthetic fibres should be flexible and possess reversible elasticity and some capacity for water. The two most successful synthetic resins in commercial fields are vinyon and nylon.

Vinyon is a polymer of vinyl acetate and vinyl chloride. The fibres are made by dispersing the resin in acetone, filtering and de-ærating, spinning, ageing, doubling and twisting, stretching, setting and, finally, flexing wet to render the filament uniformly soft.

The properties of this fibre are resistance to acids and alkalis and salts of cuprammonium, alcohols, glycols and aliphatic hydrocarbons. It is water-repellent. The unset yarn has a high shrinkage value, which is useful in making felts. It is bacteria- and fungi-proofed and has good stability to sunlight.

Nylon is a generic name for a family of condensation products of dibasic acids and diamines. Various types of amines, secondary and primary, may be used; the primary react more readily and give high-melting polymers, and the aliphatic amines are best.

The wet-process spinning gives a crenulated fibre, which is good for staple fibres, while smooth filaments are obtained from extrusion of the molten mass.

The properties of nylon are natural lustre (can be delustred by pigments), tough, strong and elastic, strength 4-5 gm./denier with elongation of 60 per cent. at break, not sensitive to humidity change and does not swell in water, resistant to most solvents, but soluble in phenol and glacial acetic acid, non-inflammable, weatherproof and fungi-proof.

TRADE AND PERSONAL NOTES

The Federation of British Industries has formed a new central committee to assist in the efficient functioning of controlled undertakings. At an emergency meeting of the executive committee on May 29 the following statement was issued:—

"The F.B.I. wholeheartedly accepts the control of industry which the danger facing the country renders necessary.

"This control will raise many problems, economic, commercial and financial, both during the war and the subsequent period of reconstruction.

"As a practical step to assist in the efficient functioning of industry in the national interest, the F.B.I. to-day decided to set up a central committee of controlled undertakings under the chairmanship of the president, Lord Dudley Gordon, in order to serve as a focus of industrial effort and opinion.

"This committee will be composed of representatives of the industries and firms affected. Local committees will be formed where necessary. A special department has been formed at the Federation to deal with the problems which will arise.

"This new organization of the F.B.I. will not deal with labour questions, which are being handled by the British Employers' Confederation."

Dow Chemical Co., Midland, Mich., U.S.A., has prepared a revised 96-page edition of its "Ethocel Handbook," a laboratory manual and reference book for the formulation and use of Dow ethylcellulose. Fundamental information on the properties of the material and an extensive background of information upon its behaviour with other components of coating compositions is presented. Specification charts, formulæ, tables, diagrams, illustrations of laboratory technique and a complete index add to the value of the handbook. Cover and binding of the catalogue are of Ethofoil.

The Beetle Products Co., Ltd., has sent us two new booklets, one dealing with lacquer resins and the other with Beetle cements.

"Plastics In Engineering," by J. Delmonte, is published by Penton Publishing Co., Penton Buildings, Cleveland, Ohio, U.S.A., price $7.50. Although primarily prepared for the growing ranks of designers treating with plastic materials, this book is a treatise on the progress and extent of applications of plastics. We hope to give a complete review shortly.

General Electric, U.S.A., has sent us two brochures describing their self-starting synchronous inductor motors and also their fractional horse-power sump pump motor. The former is particularly recommended where a long-lived source of low-speed torque or power at constant speed is needed, and the latter is a constant-speed unit built to give smooth, dependable sump pump operation. The G.E. sump pump motors are protected from damaging overloads by a built-in thermal overload switch, mounted in the end shield, that automatically resets when the motor cools. This overload switch not only prevents motor burn-outs from overload, but also eliminates needless service interruptions by automatically resetting after temporary overloads.

Bakelite Corp., Bloomfield, N.J., U.S.A., has just published a booklet which serves a dual purpose in that it stresses the advantages of rubber plate printing and outlines the various Bakelite materials available for the manufacture of rubber printing plates, including matrix sheet, matrix powder and fabric. One section is devoted to a description of manufacturing the rubber plates in two simple steps, i.e., making the matrix and moulding the plate.

Bakelite, Ltd., has forwarded us its revised booklet dealing with laminated sheet, rod and tube. This useful brochure deals with the general properties of laminated material, the various types now available, their uses, methods of working, etc.

Broadway Engineering Company, Ltd., Carlisle Road, Hendon, London, N.W.9, has forwarded us particulars of the new machine which their principals, Messrs. Hannifin Manufacturing Co., Chicago, have brought out. The machine is really four machines in one and combines a precision lathe, sensitive drill press, horizontal milling machine and vertical milling machine. The convenience, adaptability to a great variety of work and extreme accuracy make this unit as effective as several more costly special machines. The Broadway Engineering Co., Ltd., informs us that the first machines will be on view at their London showrooms within the next six weeks, and meanwhile any further information regarding the machine will be forwarded to those interested. It is of interest to note that, in accordance with the Government's wishes, the above concern has made arrangements for its services to be available on Saturdays and Sundays until further notice.

Alfred Herbert, Ltd., Coventry, has sent us the Spring issue of *The Machine Tool Review*. This excellent house journal contains, as usual, a great deal of useful information for engineers and those engaged in the plastics industries. There is a challenging editorial written by Sir Alfred Herbert, dealing with the scandal of idle machines. Other articles deal with "Ardoloy"; electrical equipment for machine tools; economy in tools and equipment; the Edgwick die-casting machines; modern measuring and inspection instruments, etc.

Closure Industry and Export Group has been formed under the chairmanship of Mr. E. A. Blanch, Kork-N-Seal, Ltd. (secretary, Mr. A. Hodson, Metal Closures, Ltd.), embracing the manufacturers of every type of closure (patented or otherwise) for use with containers. This group is officially recognized by the Export Council of the Board of Trade. Membership is open to every manufacturer of closures desiring to join, or to manufacturers of capsules, seals or other similar devices (other than lead capsules). Full particulars can be obtained from the Secretary, Closure Industry Export Group, 53, Park Farm Road, Bickley, Kent. Phone, Chislehurst 2241.

Rejafix, Ltd., 13, Bartlett's Buildings, Holborn Circus, London, E.C.1, has forwarded us a brochure describing its method of printing on paper, glass and plastic surfaces in two or more colours. "Rejafix" prints both letterpress and offset on a wide range of materials and should be of interest to moulders.

Francis Shaw and Co., Ltd., Corbett Street, Manchester, 11, has sent us a stimulating publication dealing with the development and organization of the British Empire. This booklet is written by Dr. Ramsay Muir and the introduction is by Sir Samuel Turner (chairman of Turner and Newall, Ltd.). Those who read this brief but fascinating little book cannot but be stirred by the story that is so clearly and concisely unfolded.

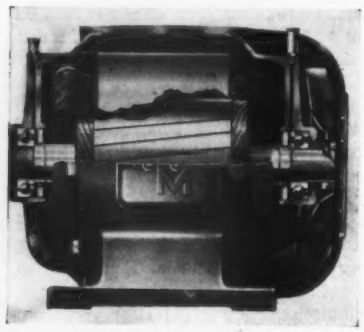
Society of Chemical Industry's annual meeting arranged for Tuesday, July 9, 1940, in the Royal Institution, Albemarle Street, London, W.1. The annual general meeting and presidential address is timed for 2.30 p.m. and there is tea (president's invitation) at 4.15 p.m. and presentation of Messel Medal to Viscount Samuel, followed by his address at 5 p.m. A portion of Stewart's Restaurant at the corner of Bond Street and Piccadilly will be reserved for members who would like to take lunch together quite informally. Guests, including ladies, are invited to all the proceedings. It is necessary to inform the general secretary at Clifton House, Euston Road, London, N.W.1, of intention to participate as follows: (1) Reserve accommodation at Stewart's for self, plus (x) guests; (2) annual general meeting; (3) tea; (4) Messel address.

NEW MATERIALS—NEW PLANT—NEW METHODS

Newman Motors

THESE motors are now extensively employed in modern industry where there is a growing need for totally enclosed fan-cooled motors. Only the finest quality materials are used in the manufacture of Newman motors and these, fashioned to a careful and almost revolutionary design, have made available a motor no larger than the ordinary protected machine, but with windings and bearings completely enclosed and having technical characteristics well above the average. Newman motors can safely be installed in dusty, damp or chemically laden atmospheres. Their performance is such that they can frequently be used in place of "High Torque" motors, whilst the exceptionally high power factor and efficiency, especially on partial loads, will usually effect a considerable saving in current consumption. The following specifications are of interest to works engineers:—

The stator is a fine-quality soft grey iron casting with feet surfaced-machined and jig-drilled. High permeability low-loss insulated laminations with semi-closed slots. Mica slot insulation. Coils firmly secured by fibre wedges and impregnated after stoving with high-grade insulating varnish. The rotor consists of high-permeability low-loss insulated lamination with high-conductivity copper-bar winding bent over at each end under hydraulic pressure and brazed together making an indestructible unit. Shaft is of high-grade steel of generous proportions ground to fine limits. Air gap; both stator and rotor diameters are precision ground to fine limits, ensuring concentricity and uniformity of air gap. Large-diameter bearings are fitted throughout and require a minimum of attention and allow motors to be mounted in any position with the shaft either horizontal or vertical. End brackets are totally enclosed solid iron castings, excluding dirt and foreign matter from the windings. Each end bracket is spigot located on concentrically machined faces, ensuring perfect alignment. Bearing housings are completely rust-proof. Centrifugal fan of high-volume efficiency is firmly secured to the shaft outside the end bracket and, protected by a special bowl-shaped cover, maintains a constant stream of cooling air between the stator laminations and frame. The ends of all phases are brought out to terminals mounted on a moulded insulating block and provided with links and sweating sockets. The cast-iron terminal cover provides an indestructible connection diagram and has a detachable flange tapped for conduit.



Close-up of the Newman enclosed electric motor.

Every Newman motor is subjected to tests before dispatch in accordance with B.S.S. 160 or 170.

The Newman motorized unit is also offered to the modern engineer. This is the unit, complete in itself, with which to convert machine tools to electric motor drives. It suits all sizes and types of cone-pulley machines. To fix it in position is quite easy and it occupies very small space. Simple design and few parts explain its low price, negligible need of maintenance and permanent efficiency. This unit secures increased output. The machine and motor automatically start and stop together, with instantaneous action speeding up all operations. Machines may be moved about ad lib. and placed in positions to foster peak production flow. Another highly important advantage is that current is consumed only when work is being done. No power is wasted driving idle shafting. Collective stoppage, due to breakdown, is entirely avoided. Overheads and on-costs are radically reduced. The motorization of individual machines also makes obsolete all the cumbersome non-productive gear associated with line shafting and long belts. Electric operation and push-button control per machine mean efficiency. Dangerous moving gear is dispensed with and far better lighting follows removal of obstructions. Much nerve-racking noise is nullified. All-round improvement increases the safety factor and reduces insurance premiums.

Further particulars may be obtained from Newman Industries, Ltd., Yate, Bristol.

Hannifin Universal Tool Grinder

THIS machine, manufactured by Broadway Engineering Co., Ltd., Carlisle Road, Hendon, London, N.W.9, makes possible the economical grinding of intricate form tools and, most important, the accurate finishing and forming of cemented carbide tools. Rigidity has been strictly maintained; despite the decrease in mass weight, the design gives to all parts requiring extreme rigidity all the weight and strength necessary for an accurate precision job. Aluminium alloy castings have been generously employed and, to ensure permanent accuracy, have been well ribbed and heat treated. All slides are made of Meehanite metal.

The super-precision spindle having five speeds—from 5,000 to 35,000 r.p.m.—is driven by a ½ h.p. heavy-duty high-speed universal motor, reversible. This particular spindle, being short in length and large in diameter, and supported by two sets of super-precision duplex bearings, ensures constant precision performance.

The drive between the motor and the spindle is through an endless heavy-duty canvas belt, with seasoned cone pulleys to obtain the various speeds. Both the spindle and the motor pulleys are mounted to rotate on individual super-precision bearings. This eliminates all loads from both the armature shaft and the precision spindle, giving longer bearing life and smoother operation.

The spindle carriage and table slides are all manually operated through hardened and ground precision lead screws. Large diameter dials permit minute settings. All slides and ways are carefully guarded, with adequate oiling facilities that require very little attention.

The large table with three tee slots permits the mounting of various attachments and special fixtures so essential to the grinding of a wide range of intricate precision parts. In addition to standard cutting tools, the machine can be used for grinding fixtures, gauges, dies and many other kinds of tools, all of which can be easily clamped to the large table.

Due to the different speeds available all sizes of wheels can be economically used, always a far-reaching advantage in precision form grinding. All wheels are mounted on hardened and ground adapters.